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DAVID STARR JORDAN, ICHTHYOLOGIST, 1851-1931

By George S. Myers

David Starr Jordan, greatest of American ichthyologists, became the first president of Stanford University upon its opening in 1891. This year, on the hundredth anniversary of his birth, it is fitting that Stanford ichthyologists should in some measure attempt to honor the memory of their leader by publication of a David Starr Jordan Centennial Number of the Stanford Ichthyological Bulletin. As the first article of this number, a brief sketch of Jordan's ichthyological career is offered by the writer, who was the very last of Jordan's many students.

David Starr Jordan was born on January 19, 1851, on a farm near Gainesville, in the western part of the state of New York. He grew to manhood in a country environment and, after completing secondary school, became a schoolteacher for a brief period. When he entered Cornell University in 1869 at the age of 18, Jordan tells us in his autobiography[1] that he was six feet tall and weighed 180 pounds. Throughout his life his great size and physical strength made him a commanding figure.

At Cornell, Jordan continued a boyhood interest in botany. Upon graduation in 1872, he accepted a professorship in natural science at Lombard College in Galesburg, Illinois, where he remained until the summer of 1873. At that time, Jordan was chosen as one of the students at the first session of the short-lived but famous summer school of natural history established by Louis Agassiz on Penikese Island, off New Bedford, Massachusetts. The teachers were Agassiz, Burt G. Wilder, Edward S. Morse, Alpheus S. Packard, Alfred Mayer, F. W. Putnam, Arnold Guyot and Count Louis de Pourtalès. Among the students were such men as W. K. Brooks, C. O. Whitman, F. H. Snow, C. S. Minot, Walter Faxon and Samuel Garman. At Penikese Jordan devoted himself to marine algae, but Agassiz asked him to undertake a study of the fishes of the region, and in examining the catches of the pound-nets at Marthas Vineyard, Jordan for the first time became well acquainted with fishes and their literature.

After the summer at Penikese, Jordan became professor in the Appleton Collegiate Institute, at Appleton, Wisconsin. Here, in the middlewest, marine algae were far away, and Jordan began study of the local fishes. Louis Agassiz had died, but Jordan returned to Penikese the next summer (1874) and in Massachusetts met George Brown Goode and others of the then newly established U.S. Fish Commission. That autumn Jordan accepted a teaching position in the high school at Indianapolis, Indiana, where one of his students was Charles Henry Gilbert, who was to be associated with Jordan for many years The summer of 1875 was spent in the Harvard Summer School of Geology in Tennessee and Jordan returned to Indianapolis as professor in Butler College. It was here, in 1875 and 1876, while living with H. E. Copeland, a fellow-student of Cornell days who had taken over Jordan's teaching position in the high school, that Jordan and Copeland decided to devote their research principally to ichthyology. The first of their papers concerned the "johnny darters" (Etheostomatinae), a catalogue of American fresh-water fishes, and a re-identification of Rafinesque's Ohio fishes. Copeland died in 1877 and Jordan carried on the ichthyological work alone.

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[1] "The Days of a Man" (see reference at end). This autobiography is well known to Stanford men but appears to be relatively unknown to ichthyologists in general. It is a veritable mine of ichthyological history.

In 1876 appeared Jordan's "Manual of the Vertebrates of the Northern United States," an outgrowth of a previous "popular key" which had been published by Jordan and Van Vleck in 1874. The "Manual," of which 13 editions were published (the last in 1929) became the best known of all Jordan's publications and served an exceedingly useful purpose in North American zoölogy for nearly three generations.

In the summer of 1876, with Gilbert, Jordan set out for Georgia, on the first of many excursions afoot and by wagon to explore the fish-fauna of the southeastern states. Ichthyological papers now began flowing from Jordan's laboratory in a steady stream, with publication assured through Spencer Fullerton Baird of the Smithsonian Institution in Washington. Other students came to Butler to work with Jordan, among them W. A. Brayton and B. W. Evermann, and the collecting trips during the summer months continued.

By 1879, Jordan had become the most active American ichthyologist, and a respected friend and colleague of Baird, Gill, and Goode in Washington. That summer, and again in 1881 and 1883, Jordan and a group of students and friends went to Europe, where they travelled, mostly afoot, over large parts of England, Belgium, Holland, France, Germany, and Italy. In 1883 Jordan, Gilbert, and some others made the ascent of the Matterhorn; Gilbert was badly injured by a falling rock during the descent. On these European tours Jordan met many of the great ichthyologists of Europe, among them Albert Günther, C. F. Lütken, and L. Vaillant. In 1881 Günther attempted to induce Jordan to become his assistant in the British Museum. Shortly afterward, G. A. Boulenger accepted the position.

In the autumn of 1879, Jordan became professor of natural science in Indiana University, and transferred his activities (and many of his students) to Bloomington. Here the opportunities were much greater than at Butler, However, hardly had Jordan assumed his duties when Baird and Boode asked him to survey the fishes and fisheries of the Pacific Coast in connection with the production of Goode's immense work, "Fisheries and Fishery Industries of the United States." Jordan obtained leave and left for the west with Gilbert in December of 1879. In nine months they covered the coast from San Diego to Vancouver, Jordan stopping in Utah and elsewhere on the return trip to Indiana. The result was a long series of papers on the fishes of the Pacific Coast by Jordan and Gilbert, and their publication, in 1883, of a "Synopsis of the Fishes of North America," the first modern compendium on the subject.

Students flocked to Jordan's lectures, among them Gilbert, Carl H. Eigenmann, B. W. Evermann, C. H. Bollman, and Seth E. Meek, all to become well known in ichthyology. Gilbert collected in Panama; and summer trips to Europe, or to collect fishes in the southern states, continued. While in Paris in 1883, Jordan heard that Owen Hall at Indiana University had been destroyed by fire, and with it Jordan's library and collections, including the entire Panama collection and the manuscript on it. Jordan began to replace his ichthyological library at once, and further expeditions soon built up the collections. On a trip to Havana in 1884 Jordan became acquainted with Felipe Poey, the venerable ichthyologist of Cuba, who had been a student of Cuvier in Paris. In his later years, Jordan himself sometimes pointed out to his students that they were, intellectually, lineal descendants of Cuvier, for Agassiz had been a disciple of Cuvier, and Jordan of Agassiz. By 1890, Jordan had collected fishes in every considerable river basin in the United States, and on most of its coastline, as well as in Europe, Cuba, and Canada.

In January, 1885, Jordan became president of Indiana University, and from that time on a great deal of his energy was taken up with the larger duties of university administration. Jordan was active and brilliant, and under his administration the university grew and the faculty was greatly expanded and improved. Gilbert became professor of zoölogy. It is in-

teresting to note that one of Jordan's appointments, which failed to materialize, was of a young Norwegian zoölogist, Fridtjof Nansen, who declined the appointment in order to make an exploring trip across Greenland—and later became famous as an arctic explorer. Jordan also broadened the curriculum and established the system of free elective subjects for students, thus departing from the rigid system that had so notably retarded American university development. As a result he became widely known, not only as the youngest American university president, but also as perhaps the most forward-looking of all. He arranged for distinguished visitors to give lectures, among them Alfred Russel Wallace and Theodore Roosevelt, the latter being not only prominent in politics but also an enthusiastic naturalist. But Jordan contined to teach himself, and did not stop his ichthyological work. A trip to study the fishes of Greece was planned with Professor Hoffman of the Classics Department, but although Jordan was himself unable to go, Hoffman obtained enough material for a little catalog of Greek fishes by Jordan and Hoffman, the most important work on this fauna since the time of Aristotle.

When Senator and Mrs. Leland Stanford of California decided to found and endow a great new university in memory of their son Leland Stanford, Jr., their choice for a leader and president was David Starr Jordan. The university buildings were located on the Stanfords' "Palo Alto Stock Farm," about 30 miles south of San Francisco, between the Outer Coast Range and the southern arm of San Francisco Bay. Jordan himself selected most of the faculty, Gilbert being head of the Zoology Department and Oliver Peebles Jenkins professor of physiology. Ichthyology was, of course, not forgotten, for Jordan brought with him his large personal library and arranged for the transfer of half of the fish collection he had built up at Indiana University. Eigenmann at that time became professor of zoölogy at Indiana University. Stanford opened its doors to its first class in the autumn of 1891. Among the first ichthyological students to arrive at the new western university in the early 1890's were John Otterbein Snyder and Alvin Seale, both of whom came from Indiana, Seale riding most of the way across the continent on a new bicycle.

Stanford's early days were clouded not only with the growing pains of a new institution but also by a lawsuit which threatened the large endowment and very existence of the university. In spite of all this, Stanford at once assumed a leading position among American universities. And Jordan, against great odds, pushed rapidly to completion his *magnum opus*, "The Fishes of North and Middle America." This great work, published by the National Museum in 1896-1900, consisted of four thick volumes, in very fine type, comprising some 4,000 pages. Originally conceived as a joint work by Jordan and Gilbert and largely written by them, Gilbert became involved at Stanford in study of the deep-sea fishes being collected in the Pacific by the U.S.S. "Albatross" and resigned co-authorship. Evermann, by then ichthyologist of the U.S. Fish Commission in Washington, assumed what was essentially literary editorship, and became co-author in Gilbert's place. No other great regional work on fishes has ever been more extensive and better executed and has had, at the same time, so great an impact upon the ichthyology of the world as a whole as "Jordan and Evermann."

Nor was this work all that Jordan accomplished in the first decade at Stanford. He visited the west coast of Mexico with a group of students, and in rapid succession published "The Fishes of Mazatlan" and "The Fishes of Puget Sound." Jordan also visited Alaska as member of the International Fur Seal Commission, resulting in a large "Fishes of Bering Sea." Gilbert collected again in Panama and late in the decade Jordan and Snyder explored the fish fauna of central Mexico. And a young zoölogist from Seattle, Edwin Chapin Starks, came to Stanford as curator of the collections, to join Snyder, Seale, and the others.

In 1901, Jordan and Snyder made a long ichthyological expedition to Japan. The large collection resulting was worked up by groups, by Jordan in collaboration with different students (Snyder, Starks, A. W. C. T. Herre, H. W. Fowler, Michitaro Sindo, R. E. Richardson, and W. F. Thompson), the resulting papers forming the firm basis on which Japanese ichthyology will always rest. Other expeditions to Hawaii and to Samoa resulted in large monographs on the fish faunas of those islands by Jordan and Evermann, by Gilbert, and by Jordan and Seale. Other extensive memoirs on the fishes of Korea, of Formosa, and of Japan were also published, the last as a result of Jordan's second Japanese trip, in 1911. In 1907, Jordan visited Australia and New Zealand on a lecture tour, meeting and becoming a lifelong friend of the ichthyologists there, J. D. Ogilby, A. R. McCulloch, E. R. Waite, and D. G. Stead.

Jordan had become, by 1910, an important and honored national figure in the United States. He was one of the two or three best known university leaders in the country. His biological text-books were known everywhere. He had lectured widely on a favorite topic—the loss through war of the cream of a nation's manhood and the consequent adverse hereditary effect upon the nation—and had become one of the foremost international figures in the peace movement. Under university regulations, he was to retire in 1916, but, as war clouds gathered in Europe, a new and energetic member of the Stanford Board of Trustees, Herbert Hoover (who had already become internationally known as a mining engineer) suggested that Jordan retire at once to devote his energies to the cause of peace.

In June of 1913 Jordan resigned the active presidency of Stanford and assumed the title of Chancellor of the University. At the same time he ceased ichthyological work, naming what he thought would be his last "new species," a macrurid, *Coryphaenoides bona-nox*. He left immediately for Europe, visiting England, France, Belgium, Germany, Switzerland, Italy, and Montenegro, lecturing and consulting with statesmen, scientists, and plain people everywhere, in an effort to stem the militaristic tide. Jordan left Europe for Australia, early in 1914, stopping to collect fishes at Port Said, and returned to Europe after but a month's stay. He then visited Croatia, Hungary, Bulgaria, Roumania, Greece, and Turkey, also on peace missions. Thence he went to Paris, London, and Ireland, and was in England at the outbreak of the war. From England Jordan returned to the United States, greatly saddened by the holocaust in Europe.

The war years, and especially the entry of the United States in 1917, left Jordan with some free time and he again plunged into ichthyology. Two projects were carried on, one on fossil fishes recently found in California and the other on nomenclature of the genera of fishes of the world. The "Genera," published in four parts from 1917 to 1920, was followed by a general "Classification of Fishes" in 1923. In 1919, with a student of the war years, Carl Leavitt Hubbs, who later was to attain fame through his revisions of American fishes, Jordan reviewed the silversides. In 1922, Jordan visited Japan for the last time, and in 1925, with Hubbs, published his last memoir on Japanese fishes. From this time on, two works occupied most of Jordan's research time. One was a final (13th) edition of the "Manual of Vertebrates," the other a checklist of North American fishes, published in 1930 in collaboration with Evermann and H. W. Clark. Two of Jordan's greatest students, Gilbert at Stanford and Eigenmann at Indiana, died in 1927. Snyder was now head of the Zoölogy Department, Starks was a member of the faculty, and Herre was curator of the zoölogical museum. The writer studied first with Eigenmann, and was closely associated with Jordan from 1926 until his death.

Within a year or two of Jordan's death both Snyder and Starks had retired. Herre and Willis H. Rich at Stanford, and Rolf L. Bolin at the University's marine station, remained to carry on ichthyological work at Stan-

ford. The writer, who left Stanford in 1933 to undertake duties at the National Museum, returned in 1936.

It is quite impossible fully to estimate Jordan's far-reaching contribution to ichthyology. During most of his days he lived three distinct lives —that of a scientist, that of a teacher and university administrator, and that of a well-known public figure and exponent of international peace. His labors in all three were prodigious and would, in any one of them, have been sufficient to fill completely the life of a busy and able man. In ichthyology itself, a number of men have surpassed him in certain segments of the science, but none has ever approached him when the entire field is considered. He contributed heavily to general biological thought, but some of his best ideas were presented in text-books and lectures where later workers seldom look. Certainly, Jordan had the broadest human interests of any of the great ichthyologists. He left a continuing and indelible imprint on the ichthyology of the entire world, not least as teacher of the greatest school of disciples ichthyology has ever seen. Finally, to Stanford he bequeathed not only his great library and collections but also leadership in an important line of human endeavor.

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1922 The days of a man, being memories of a naturalist, teacher and minor prophet of democracy. Vol. 1, xxviii+710 pp.; Vol. 2, xxviii+ 906 pp., with many portraits and illustrations. World Book Co., Yonkers, New York. [Jordan's autobiography.]

MEADIA, A NEW GENUS FOR THE WEST PACIFIC DYSOMMID EEL, DYSOMMA ABYSSALE KAMOHARA.—For a new genus of dysommid eels, the name *Meadia* is here proposed, to contain at present only the generic type, *Dysomma abyssale* Kamohara. *Meadia abyssale* (Kamohara) is distinguished from the genus *Dysomma* on the basis of its very distinctive dentition. The dentition of *Dysomma* is as follows: upper jaw with a row or a band of tiny, sharp teeth; a row of large canines at the front end of the vomer; no teeth on palatines; a single row of small or medium-sized teeth on mandibles. The dentition of *Meadia abyssale* (according to Kamohara 1938, On the offshore bottom-fishes of Prov. Tosa, Shikoku, Japan, p. 12) consists, however, of: "maxillary with a band of villiform teeth on posterior two-thirds; several canines on anterior part of upper jaw; a single canine on vomer; about twelve canines on anterior part of palatines, nearly in two longitudinal rows, followed by about thirteen smaller ones in a series. A band of villiform teeth on either side of lower jaw, each with several canines anteriorly." Thus, the presence of canines anteriorly on the upper jaw and mandible, only a single canine on the vomer, villiform teeth on the lower jaw, and palatine teeth all serve to distinguish the genus *Meadia* from *Dysomma*.—J. Böhlke.

DYSOMMINA RUGOSA, AN APODAL FISH FROM THE NORTH ATLANTIC, REPRESENTING A DISTINCT FAMILY[1]

By James Böhlke and Carl L. Hubbs
Stanford University and Scripps Institution of Oceanography

The strange eel here considered was first described in manuscript by Hubbs in 1916, as part of a collaborative report with the late Dr. C. H. Gilbert. A recent re-examination of a specimen by Böhlke[2] brought the problem up again, resulting in a combination of the two independently written manuscripts. Just as our paper was going to press, with the species named for Dr. Jordan, a description of what appears to be the same form has been published by Ginsburg (1951). As our conclusions differ notably from his, our paper is allowed to stand almost unchanged except for the use of Ginsburg's names.

DYSOMMINA Ginsburg

Dysommina Ginsburg, 1951, p. 450 (type *D. rugosa* Ginsburg).

Body elongate, compressed, slender. Anus far in advance of mid-length. Scales absent, skin smooth. Lateral line indistinct, evidently beginning rather high on body anteriorly, descending to middle of tail. Eyes covered by a layer of skin, placed anterior to mouth angle. Snout long, rounded, projecting beyond the lower jaw, and covered, as the lips and lower jaw, by small papillae. Mouth cleft wide, horizontal, lateral. Anterior nostril tubular, near tip of snout; posterior nostril with flared rim, enlarged to form a flap anteriorly, lateral, immediately in advance of eye. Teeth small, sharp, in bands on maxillaries and mandibles; four or five large, conical, widely spaced teeth set in pockets on the shaft of the vomer. Branchial apertures crescentic, oblique to nearly horizontal, below pectoral base, well separated below. Dorsal commencing behind head, anal before mid-length of body and immediately behind anus. Caudal well developed, pointed, confluent with dorsal and anal fins. Membranes of vertical fins thick. About 16 branchiostegals.

Frontals and parietals paired. Mesethmoid a thin V-shaped element, shaped like a tear-drop in cross-section, fused with vomer. Pterygoid bones everywhere reduced to thin splints. Prootic thin, little flattened anteriorly, expanding into a bulb posterodorsally. Maxillaries and mandibles long and thin, bearing wide bands of teeth. Hyomandibular one of the largest bones, composed of a strong ridge and supporting shelves that are equal in width to the wide head of the bone. Opercle elongate and low, originating on lower one-half of hyomandibular. Basioccipital-vomerine axis virtually straight. About 13-16 rudimentary gill rakers on lower limb of first arch. Slit behind fourth gill reduced to about one-half length of lower first gill arch.

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[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 525.

[2] The kindness of Doctors Alexander Wetmore and Leonard P. Schultz of the National Museum has now permitted the permanent retention of one example at Stanford.

Dysommina rugosa Ginsburg

Dysommina rugosa Ginsburg, 1951, p. 450 (Albatross Station 2667, off Cumberland Id., Georgia).

Two examples: USNM 44324, collected with large beam trawl by the U.S. Fish Commission Steamer "Albatross" in the Gulf Stream off southern Georgia, at Station 2669, 31°09'00" North Latitude, 79°33'30" West Longitude; May 5, 1886; depth 352 fathoms; bottom temperature 43.7°F.; bottom recorded as gray sand and dead coral. SU 24284, 215 mm. in total length, collected with the previous example.

Description: Measurements of no. 44324 in mm.: total length 289, head length to anterior end of gill opening 41.5 (.14 of standard length), tip of snout to dorsal origin 56 (.19 of standard length), tip of snout to anal origin 89 (.31 of standard length), greatest body depth 21, length of snout 15, eye diameter 4, fleshy interorbital width 7, gape 22, pectoral fin length 7, longest caudal fin rays 8.

Head and trunk contained just over three times in total length. Greatest depth of body 2.0 (1.9)[3] in length of head, 13.8 (14.3) in total length. Head 7.0 (7.4) in total length. Eye diameter contained 10.4 (9.7) in head length, 1.8 (No 24284 damaged) in interorbital width. Snout length 2.8 (2.9) in length of head, 19.3 (21.5) in total length. Gape extending slightly less than an eye diameter beyond eye, its length 1.9 (2.0) in head length.

Maxillary teeth in 4 or 5 wavy, irregular rows; those on mandibles similar, in bands which are widest anteriorly. Vomerine teeth consist of 4 or 5 much enlarged canines (posterior one lost from no. 24284), widely separated, set in individual pockets on the shaft of the vomer, their bases enclosed in the folds of skin which line the roof of the mouth much as in some of the dysommids. In fact, with the exception of the pair of anterior vomerine teeth which are present in *Dysomma anguillare* Barnard and absent in this new species, the entire dentition in the upper jaws of these fishes is strikingly similar. Tongue adnate. Postorbital region of head supported by the branchiostegals, some of which are visible through the skin of the branchial region.

Dorsal fin commencing posterior to tips of appressed pectorals, continuous, the distance from the tip of the snout to its origin contained 5.2 (5.2) in the total length. Distance from tip of snout to anal origin 3.2 (3.2) in total length. Vertical fins confluent around end of tail, the tip pointed; longest caudal rays 5.2 (4.3) in length of head. Small pectorals covered by rather heavy skin, their length 5.8 (5.3) in head length, 41.3 (39.1) in total length.

Pores not obvious in the lateral line proper. The only conspicuous pores in the lateral line system of the head are the elongate, open pores of the mandibular series, 4 very obvious pores in the infraorbital series (posterior to the anterior nostrils), and a single pore just posterior and median to either anterior nostril.

Color in alcohol uniformly light tan, with small groups of melanophores more or less evenly spaced along mid-line of body. Peritoneum black.

Relationships: Ginsburg's genus cannot properly be placed in any of the described eel families as currently defined (Regan 1912, p. 379; Trewavas 1932, p. 656). In external appearance and tooth pattern this genus bears a strong resemblance to several of the dysommids, but its enlarged otic bulla and paired frontals in particular are characters which would place it near the Heterenchelidae, Moringuidae, and the genus *Kaupichthys* (see Gosline 1950, p. 313). It resembles the Moringuidae in having the palatopterygoid reduced to a splint and the vomer ankylosed with the ethmoid; it differs

[3] **Proportions for no. 24284 in parentheses.**

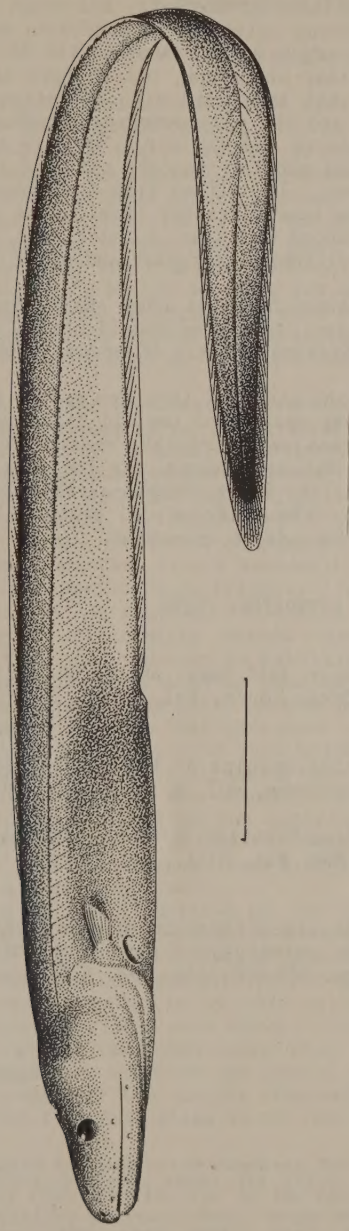

FIG. 1. *Dysommina rugosa* Ginsburg. USNM no. 44324. (Drawn by the late William Sackston Atkinson. Reproduced from a photo of the original drawing in the files of the Division of Fishes, U. S. National Museum.) Line represents one inch.

from that family, however, in having the tail much longer than the trunk, vertical fins that are not confined to the tail, and bands of teeth on the maxillaries and mandibles (versus uniserial on mandibles and uniserial or absent on maxillaries). Ginsburg's genus resembles the Heterenchelidae in having the tail much longer than the trunk, but differs trenchantly from that family in having the vomer ankylosed with the ethmoid rather than being separated by a suture, and the palatopterygoid reduced to a splint rather than being well developed and laminar. The new genus resembles *Kaupichthys* in having the trunk shorter than the tail and in lacking a suture between ethmoid and vomer. It differs from that genus, however, in having the posterior nostrils lateral rather than labial and tubular, in having the palatopterygoid reduced to a thin splint rather than well developed and laminar, and in the different character and shape of the branchial openings.

On the basis of the characters indicated above and by reason of its very distinctive external appearance, *Dysommina* should stand, at least provisionally, as the type of a distinct family of apodal fishes, the Dysomminidae.

Thanks for assistance in the study of this new eel go to the late Dr. Charles Henry Gilbert, who long ago placed the old "Albatross" collections in Hubbs' hands for a collaborative report that remains in manuscript; to Dr. Leonard P. Schultz of the National Museum, for the loan of the specimen and the accompanying illustration; to Mr. Norman J. Wilimovsky of Stanford University, for assistance in the osteological preparation; and to Dr. George S. Myers of Stanford, for advice throughout.

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FRESH-WATER FISHES AND EAST INDIAN ZOÖGEOGRAPHY[1]

By George S. Myers

1. Introduction

In a paper published over a decade ago, the writer noted that zoögeographers, like Gaul, are divided into three parts—those who build bridges, those who do not, and the proponents of continental drift. This is still true, but it may be remarked that the thinning ranks of the bridge-builders and the drifters are today almost deserted by the zoölogists. Some of the old-line botanists still stoutly man the Wegenerian or Gregorian ramparts, and conduct isolated sorties for the glory of drift or a foundered Pacific continent, but they are scarcely aware of the strength mustered against them.[2] My purpose is to fire one more gun against these besieged garrisons, and, at the same time, to point out what modern fresh-water fish evidence appears to indicate in regard to the history of the Pacific island groups, especially the East Indian or Malay Archipelago.

Only recently have fresh-water fishes come into their own in interpreting continental zoögeography. In the time of Darwin and Wallace they were too little known to be of great importance, and most of the main strokes in the zoögeographical picture were painted from the evidence of mammals and birds. Eigenmann (1909) and Regan (1922) were the pioneers in modern ichthyological geography, but their belief in a great late Cretaceous South Atlantic land bridge, like that of others in a great Pacific continent, has gradually been discarded, simply because it creates far more problems than it solves. In regard to such bridges, I wish to quote from a well-known British naturalist, as follows:

"Ingenious men will readily advance plausible arguments to support whatever theory they shall choose to maintain; but then the misfortune is, everyone's hypothesis is each as good as another's, since they are all founded on conjecture. The later writers of this sort, in whom may be seen all the arguments of those that have gone before.....stock America from the western coast of Africa.....and then break down the Isthmus that bridged over the Atlantic. But this is making use of a violent piece of machinery; it is difficulty worthy of the interposition of a god! '*Incredulus odi.*'"

Some of you may recognize the quotation. It occurs in a letter to Thomas Pennant, written by Gilbert White, at Selborne, May 29th, 1769 (see White, 1788). Vast continental land bridges have been opposed by some naturalists for a very long time!

As recently as 1938, I pointed out for the first time that the so-called true fresh-water fishes, which alone have been recognized as good evidence in terrestrial zoögeography, really consist of two groups, a primary one composed of fish families sharply restricted to fresh water and a secondary of families which apparently are able to cross short ocean barriers. The primary fresh-water fishes were shown to be sharply restricted to the continents, whilst the secondary alone have been able to reach the Greater Antilles, Madagascar, and other peripheral areas. In 1948, Darlington gave an excellent resume of the world's fresh-water fish distribution, in which he expanded the fish data given in my 1938 paper, and included amphibians,

[1] Presented by the author in February 1949 at the Seventh Pacific Science Congress, in New Zealand, under the title: Paleogeographical significance of fresh-water fish distribution in the Pacific.

[2] See especially Matthew, 1915, 1939; Noble, 1925; Dunn, 1931; Schmidt, 1943; Simpson, 1939, 1940, 1941, 1943; Darlington, 1948; Berry, 1928; Chaney, 1940.

and reptiles as well. Darlington gave only brief attention to the Pacific island faunas, but a familiarity with his paper is necessary in interpreting fresh-water fish distribution. If we then add some interesting discussions by Nichols (listed by Darlington, 1948), this completes the main recent history of general fresh-water fish geography, unless one wishes to include such compilations as those of Meek (1916), Kyle (1926), MacFarlane (1923), Scheuring (1929, 1930), and Arldt (1938). The last is, I believe, the most ponderous existing example of the way biogeography should *not* be done.

2. Fresh-water Fishes

The fishes of fresh waters may be classified zoögeographically in the following groups (Myers, 1938, 1949):

1. **Primary.** Strictly intolerant of salt sea water. (Existing Dipnoi, Polypteridae, Osteoglossidae, Cyprinidae, Characidae; most families of siluroids; Centrarchidae, Percidae, etc. There are a few exceptions in these groups, but they are exceedingly few.)

2. **Secondary.** Rather strictly confined to fresh water but evidently capable of occasionally crossing narrow sea barriers; tolerance of sea water for short periods known for many. (Lepisosteidae; most Cyprinodontidae, Poeciliidae and Cichlidae; Synbranchidae, etc.)

3. **Diadromous.** Fishes which regularly migrate between fresh and salt water at a definite period of the life cycle. (Sea-lampreys, *Alosa, Oncorhynchus, Galaxias, Anguilla, Sicydium,* etc., etc.)

4. **Vicarious.** Presumably *nondiadromous* fresh-water representatives of partly or primarily marine groups. (*Siniperca; Lota; Plagioscion;* fresh-water Ariidae, Plotosidae, Apogonidae, Atherinidae, and Syngnathidae; landlocked or nondiadromous Galaxiidae; etc.)

5. **Complementary.** Fresh-water fishes, often or usually diadromous and belonging to marine groups which become dominant in fresh water only in the paucity or absence of primary, secondary, and probably also vicarious fresh-water faunas. (*Agonostomus, Joturus, Cestraeus, Sicydium, Sicyopterus, Stiphodon,* certain New World Gobiesocidae, etc.)

6. **Sporadic.** Fishes which live and breed indifferently in salt or fresh water or which enter fresh water only sporadically and not as a part of a true migration. (Many Lutianidae and Sciaenidae; probably many Mugilidae; *Gasterosteus, Mollienisia,* etc.)

The continental fish faunas of the world are composed principally of primary fresh-water fishes, amd most of the remainder are secondary fresh-water fishes. The families of the primary group appear mostly to have had a long fresh-water history, extending back to the Eocene, and their physiological intolerance of sea water seems to be deep-seated (Myers, 1938).

True fresh-water fishes seldom cross ocean barriers; those of the primary group almost never do but the secondary ones appear to have done so on several occasions. Fishes of the vicarious group may often be able to make such crossings, since most of them appear to be of relatively recent derivation from marine types. If they are purely fresh-water residents of relatively long standing, they may show geographical relationships between lands now separated by the sea. But each instance of this type must be closely judged on its own merits. Diadromous, complementary and sporadic fresh-water fishes seldom are of any particular importance in showing terrestrial geographical relationships.

3. East Indian Archipelago

This term is used here to indicate the entire region from Sumatra and

the Philippines to and including Australia. Relationships within this archipelago inescapably involve Wallace's and Weber's Lines and these have been ably discussed by Mayr (1944). His fish data are mostly from de Beaufort (1913 and 1926) and are thus somewhat outdated. In addition he has misinterpreted some ichthyological facts and not realized the importance of others.

Makassar Strait forms the most spectacular zoögeographical boundary to be found among the world's fresh-water fish faunas. To the west lies Borneo, teeming with 17 families and 300 or more species of primary fresh-water fishes. Only 85 miles to the east lies Celebes, with two solitary species of primary fresh-water fishes,[3] both probably introduced by man. Celebes, like Borneo, has a few secondary forms (Cyprinodonts and a Synbranchid), as well as a peculiar small group of vicarious Atherinidae, but the difference from the magnificent Bornean fish fauna is very close to awe-inspiring. (See especially the volumes of Weber and de Beaufort.)

South of Makassar Strait, Wallace's Line is not quite so spectacular, since the primary fresh-water fish fauna of West Java is much smaller than that of Borneo, whilst that of East Java and Bali seems to be impoverished. Comparing Java as a whole with Lombok, Sumbawa and Flores, we find 12 families and nearly 100 species of primary fresh-water fishes immediately to the west of Wallace's Line (data mostly from Dammerman, 1929) and but four families and five species of primary fresh-water fishes to the east of it (de Beaufort, 1913). Of these five, at least three have probably been carried across by man as food fishes,[4] and it is notable that two of them are the same species that have crossed Makassar Strait into Celebes. The remaining two primary species which have crossed to the east of Lombok Strait are small fishes of two Cyprinid genera (*Rasbora* and *Puntius*) which perhaps have crossed sea barriers elsewhere.[5]

The Philippines deserve especial mention. (See Herre, 1924a, 1924b, 1928.) Bornean primary fresh-water fishes exist in Palawan and the Calamianes Islands, which are on the Bornean continental shelf and are, zoölogically, completely Bornean in affinity. One species (*Puntius*; called also *Barbodes* by Herre, and *Barbus* by others) has gotten from the Calamianes to Mindoro. The continental shelf appears to break down to some extent along the Sulu Archipelago, but three genera (including *Rasbora* and *Puntius* again) have gotten a foothold in Mindanao, coming up through the Sulu chain, and two or three races or poorly differentiated species of each genus occur in different parts of the island. In Lake Lanao, located in central Mindanao, *Puntius binotatus* (the same species which crossed Lombok Strait from Bali) has flowered into a most remarkable lake fish-fauna, several species of which are so peculiar as to have been placed in different genera (Herre, 1924a and b; 1933). I intend to take up the evolutionary problem of the Lanao fish fauna in another place. Finally, Mindanao possesses an endemic Clariid catfish, but some Clariids do enter brackish water, according to Weber and de Beaufort (1913) and Dammerman (1929).

All of the islands between the Sunda continental shelf and the Australian-New Guinean continental shelf, including all of the Philippines except Mindanao and the Palawan-Calamianes group, form an ichthyological no-man's-

[3] *Anabas testudineus* and *Ophicephalus striatus*. Both are commonly carried about alive by man as food fishes, the latter more than the former. *Anabas* is said occasionally to enter brackish water.

[4] The three are *Anabas testudineus*, *Ophicephalus striatus*, and *Clarias batrachus*. Both the first and the last are said occasionally to enter brackish water,

[5] Holly (1927) has recorded 11 species of primary fresh-water fishes from the ichthyologically little known island of Sumba (Sundalwood), southeast of Sumbawa and Lombok. The species are all found in Borneo, Banka, and Sumatra, and four of them (*Rasbora kalochroma*, *Ophicephalus melanosoma*, *O. bankanensis*, and *Betta anabatoides*) are unknown in Java. Some mistake in the locality must have occurred, and I suggest that Holly's whole collection came from somewhere in Borneo or Sumatra.

land, so far as primary fresh-water fishes go. Three common Sundaland species belonging to primary groups are widely spread over many of these islands—*Clarias batrachus, Ophicephalus striatus,* and *Anabas testudineus*—but all three are air-breathing foodfishes often carried about alive in the Orient, especially the *Ophicephalus,* and both of the other two are reported to enter brackish water. Two or three more *Clarias* also occur in the Philippines but some enter brackish water. Other primary fishes have entered this no-man's-land, apparently by non-human agency, only at Mindoro (1 species), and at Lombok (2 species). In both instances the same genus (*Puntius*) is concerned, in addition to *Rasbora* in Lombok. When one considers the 17 or 18 families and 400 or more species of primary fresh-water fishes of Sundaland, Wallace's Line (essentially the edge of the Asiatic continental shelf) stands out as a great major faunal boundary of excessive sharpness.

Perhaps the most interesting thing about it is that other Asiatic vertebrates, even amphibians, show no such strict limitation to the Sunda Shelf as do the primary fresh-water fishes (Mayr, 1944). These primary fishes are able to migrate slowly across any well-watered land. But only a very small number of species of any primary fresh-water fish fauna seems able to cross a salt-water barrier of any description. If Sundaland had been connected with the islands to the eastward at any time since the Eocene, primary fresh-water fishes of some type should swarm in the islands to the east of Wallace's Line. That they do so only in Mindanao proves to my entire satisfaction that there has been no land connection except with Mindanao, and that Mindanao is therefore probably part of Sundaland. Moreover, if it proves that, it also proves that other vertebrates, including amphibians, can and do cross sea barriers with relative ease, however they may do it.

Weber's Line, as Mayr (1944) shows, is a line of faunal balance. From the fresh-water fish evidence, the Australian-New Guinean continental shelf, including the Aru Islands but excluding Halmaheira, Ceram and Timor, is a more significant line. This shelf marks the westward limits of the Melanotaeniin fishes (Regan, 1914; Weber and de Beaufort, 1922), which are perhaps the most generally characteristic of Australian fresh-water fishes. Although the Melanotaeniins are only vicarious fresh-water forms, belonging to the primarily marine family Atherinidae, and are said by Regan (1914) not to be of much importance in terrestrial zoögeography, it is very suggestive to note their absence from Ceram and Halmaheira, where so many vicarious or diadromous Papuan species are to be found.

Australia and New Guinea possess only two species of primary fresh-water fishes, the Queensland Ceratodontid lungfish (*Neoceratodus*) and an Osteoglossid, *Scleropages leichardti,* common in Queensland and once recorded from New Guinea on the basis of a photograph.[6] Both are solitary relict forms, whose ancestors got to Australia previous to the Cenozoic, probably at about the time Marsupials entered that continent. The lungfish has no close living relative. The *Scleropages* has as its only close living relative another species (*S. formosus*) found from Siam and Indo-China to Borneo. Three other living Osteoglossid species exist in Africa and South America, but the family has a still wider Eocene distribution (Myers, 1938). That these ancient fishes, although considered primary fresh-water forms today, may have had close relatives capable of crossing sea barriers, is entirely possible. Indeed, it would seem probable that they did, for if Australia (and New Guinea) had been connected by a dry-land bridge with Asia during

[6] Mayr (1944) thus had no basis at all for stating that the absence of primary fresh-water fishes of Seran (Ceram) and Kei indicates that these islands have had no continental connection with New Guinea. Fowler (1941) recognized two Queensland species of *Scleropages,* but *S. guntheri* is a very doubtful species.

the Mesozoic, Australia should today be a veritable living museum of Mesozoic types of fresh-water fishes. That only two such species exist in a continent whose fresh-water fish fauna is notably depauperate, and in which there has, therefore, been less competition than elsewhere, points to the conclusion that neither Australia and New Guinea, nor any of the other islands east of the Sunda Shelf, have ever had wide open dry-land connection with Asia. This is directly in line with Simpson's conclusion (1940, pp. 156-157) that the mammal colonizers of Australia reached that continent from Asia by what he terms a "sweepstakes" or "island hopping" route across one or more sea barriers.

All the rest of the comparatively depauperate Australian-New Guinean fresh-water fauna is composed of secondary fresh-water fishes (such as *Synbranchus bengalensis*; see Regan, 1914), of vicarious representatives of marine groups such as Atherinidae, and of a few strange diadromous families such as the Galaxiids.

Except for the two relict primary species, Australia and New Guinea have no primary fresh-water fishes. Any paleogeographical conclusions to be gained from the rest of the fresh-water fish fauna is, therefore, open to question simply because of the presumption that most or all of the species either can or do enter the sea with impunity. Iredale and Whitley (1938) and, more recently, Whitley (1947), have delimited distinctive Australian fluvial regions based on fresh-water mollusks and fishes, but so far as the fishes are concerned, it would appear that these regions may be as much reflections of the marine faunal composition on the adjacent coasts as they are anything else. In any event, comparatively little is yet on record regarding the possible seagoing abilities of most of the Australian and Papuan vicarious fresh-water fishes.

4. New Zealand

New Zealand has no primary or even secondary fresh-water fishes and there is, therefore, nothing in the fish evidence upon which to base any positive opinion in regard to its former connection with Australia or any other land mass. However, that New Zealand does not have either primary or secondary true fresh-water fishes, as it should have if it has been connected to Australia or especially to South America (directly or via Antarctica) during the Cretaceous or early Cenozoic, indicates that any continental connection it may have had must have been rather far back in the Mesozoic.

That the Galaxiids indicate any connection is very doubtful, in spite of their peculiar distribution (South Africa, South Australia, New Caledonia, New Zealand, Southern South America). Regan (1906) pointed out that some forms, at least, are catadromous, and Scott (1941) shows that at least one Tasmanian species enters the sea. Hefford (quoted from Phillips, 1940) described the breeding of *Galaxias attenuatus*, which appears to have tide-controlled spawning habits similar in some ways to those of the California grunion, an Atherinid. That the young of some forms are found at sea is established, and it is probable that marine wandering is the key to the family's distribution.

5. Formosa and Japan

There has never been much question but that the main islands of Japan were connected with the mainland at no very distant time, geologically speaking, and the fishes demonstrate this. The large primary fresh-water fish fauna of Formosa is practically identical with that of adjacent Fukien

on the Chinese mainland, but not with that of Japan, and any apparently endemic species and genera should be accepted with caution until Fukien is more extensively fished. But Formosan relationship with the Luzon fauna, which appears in some terrestrial groups, is totally absent in the primary fresh-water fishes, simply because the Northern Philippines have not and apparently never have had a native primary fresh-water fish fauna. *Ophicephalus striatus, Anabas,* and *Clarias* are there, undoubtedly introduced by man, but nothing else except one or two secondary fishes. It may be that secondary or other fishes have gotten to Formosa from Luzon, by means of typhoon winds, but the fact that the species are also found on the mainland makes this difficult to determine. The Riu Kius have a very few fresh-water fishes, mostly Formosan species, and perhaps had a fairly recent but tenuous connection with that island.

6. Oceania

The islands of Oceania have not a single primary or secondary fresh-water fish except for recent introductions by man. The nearest thing to a native fresh-water fish anywhere is a Galaxiid on New Caledonia (Weber and de Beaufort, 1915; Scott, 1936), which could perhaps have gotten there by sea from Australia. If there had been any great continental land mass in the Pacific during any part of the Cenozoic it should have had primary or secondary fishes, or at least have evolved some recognizable, peculiar, vicarious fresh-water types. That no such types are evident on a single island of Oceania should of itself dispose of the notion of any such continental mass as J. W. Gregory (1930) postulated.

The fishes which occur in the fresh waters of the islands of Oceania are well illustrated by Weber and de Beaufort's list of New Caledonian fishes (1915). There are diadromous fishes such as *Anguilla,* some of the gobies, and the Mugilidae, and there are sporadic fresh-water fishes such as *Kuhlia, Ambassis, Lutianus* and some other gobies, but nothing more. Complementary fresh-water fishes, such as *Sicyopterus, Stiphodon,* and *Cestraeus,* are dominant.

7. The Galapagos

This is the only group of islands on the American side of the Pacific which are of a size and distance from the mainland sufficient to make their inclusion necessary. There is only a single fresh-water stream of consequence in the entire Archipelago. It is on Chatham Island (Watering Bay) and I have fished in it. It appears to contain but one species, *Agonostomus hancocki* (Seale, 1932), a diadromous, complementary fish related to American mainland forms and perhaps not specifically separable. Since Dr. Hubbs tells me he has gotten young *Agonostomus* in the sea at Acapulco, this fish has no direct bearing on the origin of the Galapagos fauna.

8. Sea Crossings by Primary Fresh-Water Fishes

The few primary fresh-water fishes which are presumed to have crossed ocean barriers between Pacific islands by other than human agency are confined chiefly to three genera of Cyprinidae and to three points of crossing. One *Puntius* (an endemic species) exists in Mindoro; its ancestors certainly came via the Calamianes group. Three genera (*Puntius, Rasbora, Nematalestes*) have reached Mindanao from North Borneo, apparently via the Sulu chain. One *Puntius* and one *Rasbora* have reached Lombok and Sumbawa from Bali or

Java, but whether they have recognizably differentiated on the different islands has not been adequately ascertained.[7]

The Mindoro and Lombok crossings involve one and two species respectively. The species are small and common. The Lombok fishes may have been carried across by man, especially Chinese, who like to transport small live fishes, but I doubt it. The Mindoro species is endemic, is not found in the well-fished Calamianes Islands, and was not carried by man. There may be more than one species in poorly-fished Mindoro.

The Mindanao crossing is more complicated. *Puntius binotatus*, a widely distributed species in Sundaland and the same one that made the Lombok crossing, must have gotten across at least as far back as the early Quaternary, for from it evolved the recent but rich fauna of closely related forms in Lake Lanao (Herre, 1924a; 1933).[8] Two or three other races or species of *Puntius* are also found in Mindanao streams, but these are all close to or inseparable from *P. binotatus*. Two forms of *Nematabramis* are known from Mindanao (Herre, 1942a). They may not be really different and one at least is identical with a North Borneo species. The two Mindanao *Rasbora* are close to Bornean forms. Apparently *Rasbora*, *Puntius* and *Nematabramis* are found on several of the Sulu Islands, from Basilan to Tawitawi.

Various writers (see especially Matthew) have pointed out that smaller terrestrial animals undoubtedly have been transported across sea barriers on rafts of jungle vegetation which float out of tropical rivers during periods of flood. I have seen such rafts myself—even one supporting a ten-foot boa-constrictor! But fresh-water fishes do not cross seas on rafts.

Darlington (1938) has searchingly discussed this and other methods of over-water dispersal, especially by winds and storms. It is now perfectly well authenticated that waterspouts caused by tornadoes can and do occasionally pick up small fishes and deposit them at a distance (Gudger, 1929a, 1929b; Bajkov, 1949). Mindoro and the Calamianes are in the typhoon area, which could easily explain the single *Puntius* in Mindoro. Lombok and Sumbawa are not in a typhoon area. But waterspouts do occur in many places and they do pick up fishes and upon rare occasions carry them for short distances. The distances involved here are comparatively short. We do not know anything about the specific salt-tolerance of the two species concerned, but if they could not have navigated a short stretch of salt water and were not introduced into Lombok and Sumbawa by man, there are only two ways they might have crossed Lombok Strait—by waterspout or (as suggested by Mayr) upon a sheet of fresh surface water during heavy rains. Lombok Strait was evidently much narrower (and Lombok and Sumbawa were one island) during the Pleistocene. Crossing would have been easier under such conditions. In any event I do not think these two fishes present much of a problem.

Darlington (1948, pp. 7-8) has presumed that the Cyprinids had to cross sea barriers to reach both the Palawan-Calamianes group and Mindanao. I think this very unlikely for the former. Palawan and even Busuanga have too many species (not only of fishes) in common with North Borneo, and a land connection seems certain. Tentatively, I have previously agreed with Darlington that there was no recent dry land connection of Mindanao with Borneo, but this conclusion appears to be untenable upon careful study. The three genera which reached Mindanao still exist on the larger Sulu is-

[7] My student, Dr. Martin R. Brittan, has recently (1950) completed a revision of the genus *Rasbora* which notably clears up many points in systematics. The thesis has not as yet been published.

[8] At my request, the late Dr. Bailey Willis of Stanford made a special study of the evidence regarding the age of the lava flow which dammed up and formed Lake Lanao. He stated that the known rate at which lava is eroded by stream and waterfall action indicates an age of not over 10,000 years for the lava flow and the lake. I am preparing a paper in regard to the Lanao fish fauna.

lands, and it is wholly possible that faulting has recently deepened some of the inter-island channels, which are still all fairly shallow. The North Borneo fresh-water fish fauna is notably depauperate, compared to South Borneo, and a dry isthmian link along the Sulu chain in the Pleistocene would have freely allowed to cross just the fish which did.[9] It is, therefore, my opinion that the Mindanao fresh-water fishes arrived via a dry Sulu land bridge, and certainly not earlier than the Pliocene.

9. Conclusions

There is nothing in the distribution of the fresh-water fishes of the Pacific islands favorable either to continental drift or to J. W. Gregory's Pacific continent, and much that opposes the latter. In fact, the fish evidence points directly to the conclusion that the islands of Oceania are truly oceanic, in the sense of Wallace.

In the great Indo-Australian Archipelago the fish evidence very strongly supports the conclusion that there has been no dry land connection whatsoever between the islands of the Asiatic continental shelf (Sundaland) with Celebes or Lombok, or any of the islands to the eastward of these, during the entire Cenozoic. It also strongly indicates that Mindanao and the Palawan-Calamianes chain were connected by dry land with Sundaland during the Pleistocene, but that the other Philippines were never so connected during the entire Cenozoic. It further suggests that, even in the Mesozoic, there was never a dry land connection between Asia and Australia. Only three relicts of this Mesozoic fish fauna remain today—one Osteoglossid in Sundaland, another in Queensland (which has once been reported from New Guinea) and the Queensland lungfish.

The islands between Wallace's Line and the New Guinean-Australian continental shelf, and most of the Philippines (save the Palawan-Calamianes chain and Mindanao, which were part of Sundaland) are populated chiefly by fresh-water fishes of fairly recent marine origin, and which therefore give no indication of past land connections.

Most of the New Guinean-Australian fish fauna is of similar marine origin. Only the lungfish and the Osteoglossids are true fresh-water fishes, and fresh-water faunal districts in New Guinea and Australia based on fish distribution are based primarily upon fishes of close marine relationship.

There is nothing in the existing fresh-water fish faunas of New Zealand or any of the islands of Oceania east of the Philippines, New Guinea and Australia, to indicate any past continental connection.

That Japan and Formosa have only recently become separated from the mainland adjacent to each is plainly indicated by the fresh-water fishes. There is no possibility that Formosa and Luzon have been connected by continuous dry land during the greater part of the Cenozoic. Formosa has abundant native primary fresh-water fishes; Luzon has none.

There is no fresh-water fish evidence to indicate a continental connection of the Galapagos with the American or other mainland.

Finally, the evidence presented here and in my 1938 paper indicates strongly that primary fresh-water fishes, of all the major groups of vertebrates, are least capable of crossing sea barriers. The only other major vertebrate group so strictly limited by salt-water barriers are the burrowing caecilian amphibians, which are wholly tropical and very small in number. It follows that primary fresh-water fishes, above all other vertebrates, are the best indicators of the existence of sea barriers of long standing.

[9] Caecilians are amphibians which, unlike frogs, never appear to cross sea barriers. Caecilians are found not only in Basilan but also on Mindanao (specimen in Stanford collection).

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TWO NEW AGONID FISHES FROM THE SEA OF JAPAN

By Harry Wyman Freeman

In the course of a general revisional study of the marine mail-cheeked fishes of the family Agonidae, now virtually completed, the two apparently unrecognized species herewith described were discovered. As the publication of the main study may be delayed it seems best to present these new species at the present time. Both are from the collection obtained in Japan in 1928 by Dr. Carl L. Hubbs (now of the Scripps Institution of Oceanography, La Jolla, California) for the University of Michigan. In 1930, the agonids of this collection were worked over at Michigan by Dr. Katsuzo Kuronuma, then a student of Dr. Hubbs. Unfortunately Dr. Kuronuma's manuscript was destroyed during the recent war; one of the new species is named for him. The other is named for Dr. Clark Hubbs (son of Dr. Carl L. Hubbs), who helped me while a fellow student in Professor Myers' laboratory at Stanford. In the specimen lists, UMMZ = University of Michigan Museum of Zoology, and SU = Natural History Museum of Stanford University.

Tilesina hubbsi, new species
Figure 1

Diagnosis: This species is distinguished from *T. gibbosa* Schmidt (1903, p. 16; 1904, p. 134, pl. 4), the only other known member of this genus, by the presence of 2 spines on the suborbital stay; of one sharp spine on the ventral rim of the orbit; and of a spine on the preorbital. There are 5 sharp spines or crests on the temporal ridge of this new species not present in *gibbosa*; the occipital crests are more prominent. The supraocular crests of the new species are greatly serrated and bear several spines on the posterior margins. The dorsad spine of the preopercle is more prominent and more elevated, and has a short blunt spine at its anterior base.

Description: Caudal peduncle short and slightly depressed, its depth 53.7 in standard length, its length 5.1. Body widest in pectoral region; width at pectoral base 10.7.

Head long, tapering anteriorly, 4.7 in length. Mouth moderate, lower jaw extending posteriorly to a vertical beyond middle of eye. No barbels on lower lip. Maxillary not reaching anterior rim of orbit, maxillary flap short and flat. Premaxillary large, expanded posteriorly. Snout elongated, 3.6 in head. One pair of spines on posterior part of nasal bones, directed posteriorly and slightly laterally. A short broad groove between nasals; nasals not fused anteriorly. A short anterior nasal flap, just lateral to nasal spine. Posterior nasal opening inconspicuous. A number of short plates with sharp spines anterior to eye. Preorbital spine present. Suborbital stay prominent, ending in one large and one small spine. Cheek below suborbital naked (without spines or plates). Preopercle with one flat, ventrally directed spine, and one sharp elevated spine which bears in front of it a short blunt spine. Opercle with a very low crest. Temporal ridge prominent with 5 sharp spines or crests. Eye moderate, orbit 5.3 in head; eye almost circular. Supraocular crests prominent, greatly serrated, with several sharp spines on posterior borders. Occipital region raised, with 2 blunt crests. Many small plates with spines in midline anterior to first dorsal becoming very numerous in occipital, temporal, and opercular regions. Interorbital slightly concave; width greater than half

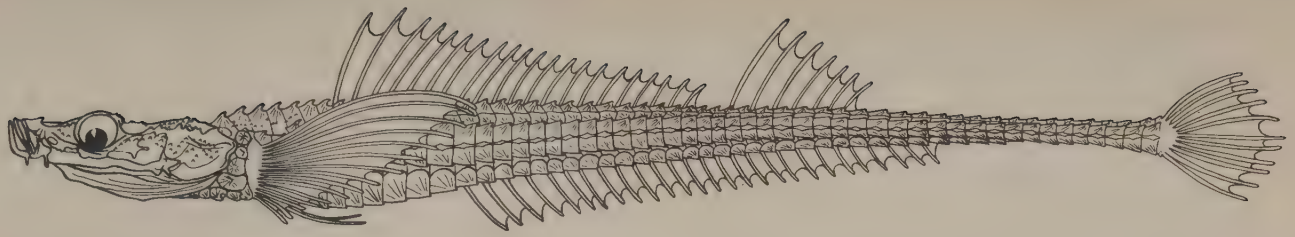

FIG. 1. *Tilesina hubbsi* Freeman. Holotype, UMMZ 158503. Standard length 204 mm. (Drawn by Judith Mottram.)

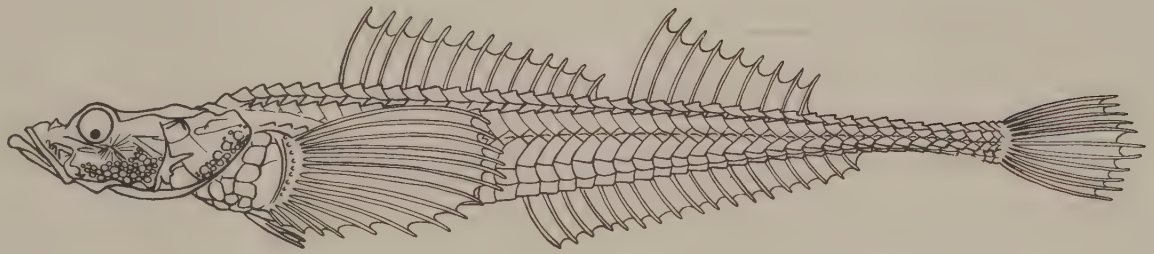

FIG. 2. *Occa kuronumai* Freeman. Holotype, UMMZ 160733. Standard length 157 mm. (Drawn by Judith Mottram.)

diameter of eye. Interorbital space 9.8 in head. Gular region and gill membranes without barbels. A few small, inconspicuous teeth on vomer and palatines.

Breast covered with heavy overlapping plates; each with a sharp, low, posteriorly directed spine.

One small pair and one large pair of plates anterior to pelvics. Several large plates with prominent spines anterior to pectorals. A row of plates with sharp, posteriorly directed spines on mid-ventral line between anus and anal, not, however, running forward to anus. Three plates with sharp spines anterior to anus between pelvics. No plates between ventro-lateral and ventral rows beneath pectorals. Plates of dorsal row become fused posterior to second dorsal fin; the spines, however, remain paired. Ventral plates of caudal peduncle paired except for posteriormost 2 plates, which are fused but whose spines remain paired. Lateral line takes over and occupies space on the anterior 4 plates of the dorso-lateral series. Ventro-lateral series pass dorsally above pectorals. Anus lies between pelvics but is not very far advanced. Pectorals large but not extending to or past the middle of first dorsal as they do in *T. gibbosa*. Median fins not very high. Interdorsal 4.0 in distance from first dorsal to tip of snout. Anal inserted far anterior to second dorsal. All body plates bear sharp spines. A row of small spines between dorsal and dorso-lateral series in anterior half of body.

Fin and scale formulae: D. XXI, 7; A. 27: p. 15; plates in D. row 54; Ll. 55; plates between first A. ray and base of ventrals 10; plates between last A. ray and base of caudal 12; first dorsal inserted on plate 8.

Color in spirits: dorsal half of body dark chocolate brown, spotted with small black dots; ventral surface lighter brown, except caudal peduncle darker and spotted posteriorly. A blackish band from anterior end of snout through middle of eye across opercle to dorsal surface of pectorals, where it is continuous with the dark lateral line. Lateral line becomes paler caudad. Dorsal and pectoral fins with several series of black spots in vertical rows. A dark spot at free end of membranes supporting each anal ray. Pelvics pale.

I have seen but one specimen, the 204-mm. holotype, UMMZ 158503, from U.S.S.R.: Siberia, Sea of Japan, about 58°(?)N., from Toyama-ken Fisheries Experiment Station.

This species is named in honor of my friend and fellow student, Dr. Clark Hubbs, now of the Department of Zoology, University of Texas, Austin, Texas.

Occa (Iburina) kuronumai, new species
Figure 2

Diagnosis: No body plates possess sharp spines. This species is distinguished from other members of the subgenus by the presence of many thick plates of moderate size beneath the suborbital crest, and of several large plates on top of head in midline just anterior to the occipital crest. Cheek behind eye covered with many large thick plates. Many plates of moderate size cover the body between anterior ventral and anterior ventro-lateral series beneath pectorals. This is an especially important character.

Description: Caudal peduncle short and stout, rectangular in cross-section at the posterior end; its depth 36.9 (35.2-38.9) in standard length, its length 5.8 (5.5-6.1). Body greatly broadened anteriorly; width at pectoral base 6.2 (5.6-6.9).

Head broad, its length 4.2 (4.1-4.3) in length. Mouth moderate, with lower jaw projecting and extending to posterior rim of orbit. Maxillary

extends to a vertical between middle of eye and anterior rim of orbit; one short flap on posterior maxillary. Premaxillary large, expanded posteriorly. Snout broad and short, 4.6 (4.4-4.7) in head. Nasals short. Nasal spine blunt, covered with many short spines. No barbels on snout, lower jaw, or branchiostegal membranes. Anterior nasal flap large, just laterad of the nasal projection. Posterior nasal flap very small, just anterior to eye. Cheek below suborbital crest with many thick plates of moderate size. Suborbital stay not spiny. Entire rim of orbit serrated. Supraorbital crest low. Preopercle with one sharp posteriorly directed spine and 2 flat blunt spines beneath. Opercle with a low crest. Opercular flap with many large plates. Temporal crest broad and not spiny. Occipital crest low but not spinous. Eye moderate, 5.0 (4.7-5.3) in head. Cheek posterior to orbit with many large plates. Interorbital space broad, 4.4 (4.2-4.6) in head. Median dorsal plates anterior to first dorsal spine very small and prickly. Gular region covered with heavy plates of moderate size; smaller plates under gill membranes.

Breast with large non-spinous plates interspaced with more numerous smaller plates. Two to 3 pairs of plates anterior to pelvics. The region between pelvic base and first anal ray with many small and moderate sized strong plates. Body eight-angled in region of first dorsal, six-angled at caudal peduncle becoming rectangular posteriorly. Lateral line takes over and occupies space on anterior 4 or 5 plates of dorso-lateral series. Ventro-lateral series of plates runs anteriorly to dorsad edge of pectoral. Space between ventro-lateral and ventral series beneath pectorals covered with many plates of moderate size. Anus situated far forward between pelvics. Pectorals moderate, extending to about midpoint of first dorsal. Distal border of pectorals not emarginate. Pelvics short. First dorsal inserted on eighth plate of dorsal series. Interdorsal 4.9 (4.8-5.0) in distance from first dorsal to tip of snout. Dorso-lateral series of plates converge 7 to 8 plates posterior to the second dorsal.

Fin and scale formulae: D. XII, 9 (X-XII, 9-10); A. 19 (18-19); P. 16 (16-16); plates in D. row 41 (40-42); L1. 43 (42-44); plates between first A. ray and base of ventrals 13 (11-14); plates between last A. ray and base of caudal 9 (8-9); first dorsal inserted on plate 3 (2-4).

Color in spirits: dorsal half of body and head dark grey to black; beige on ventral surface except for caudal peduncle which is dark grey posteriorly. Dorsal fins, caudal, and pectorals blackish, with several series of darker spots in vertical rows on rays or in membrane between rays. Pelvic fins beige. Anterior half of anal fin pale, posterior half light grey.

Relationships: This new species is obviously a member of the *Occa* group. It seems to be most closely related to *O. iburia* Jordan and Starks (1905, p. 585) and *O. kasawae* Jordan and Hubbs (1925, p. 291, pl. 11, fig. 1) as they have in common the following: snout short, flattened, and quite broad; 12 to 15 spines in first dorsal; pectorals with 16 to 19 rays; plates of dorsal series 41 to 43; 43 to 45 plates in lateral line; plates present between anterior ventro-lateral series beneath pectorals. For these reasons I have placed it in *Iburina*, which I consider to be a subgenus of *Occa*.

I have examined 5 specimens from the following localities: 4 from Sea of Japan, close to Niigata, from Niigata market, C. L. Hubbs and K. Sakamoto, (UMMZ 160733, holotype, 157 mm.; 158488, paratype, 151.5 mm.; 158489, paratype, 163.5 mm.; SU 16724, paratype, 155 mm.); one from Sea of Japan, Niigata-ken Fisheries Experiment Station, (UMMZ 158486, paratype, 137 mm.). Known only from these specimens.

This species is named in honor of Dr. Katsuzo Kuronuma who set it aside as a new species in 1930 while working as a graduate student at the University of Michigan, but whose manuscript, unfortunately, was destroyed by fire in World War II.

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SOME FORGOTTEN BUT AVAILABLE NAMES FOR INDIAN FISHES.—In the "Supplement to the Fishes of India" (London, 1888; pp. 779-816) Sir Francis Day published some fish names which appear to have been completely forgotten. These names were used by Col. Tickell in an unpublished manuscript on Tenasserim fishes utilized by Day, and a few of them were formally proposed by Day as new genera and species (e.g., *Acanthonotus* and the specific name of *Leiocassis fluviatilis*). Others were not accepted by Day, but were quoted by him in synonymy in connection with a description. They are therefore validly published and available for use if Day's identifications prove to be wrong, if preoccupation makes older names unusable, or if generic, specific, or subspecific splitting occur. None of these names appears ever to have found its way into the Zoölogical Record or the various generic nomenclators. The forgotten names are:

Acanthurus tristis Tickell (Day), p. 788. Type locality Arrakan. Placed by Day in the synonymy of *A. tennentii*, but perhaps a good form.

Malacocanthus Tickell (Day), p. 791. Type hereby designated as *M. coccinicauda* Tickell (Day). Apparently a synonym of *Pseudochromis*, but perhaps available for a subgenus.

Malacocanthus coccinicauda Tickell (Day), p. 791. Type locality Saddle Island, off Kyouk Phoo. Placed by Day under *Pseudochromis fuscus* but perhaps a good species or subspecies.

Malacocanthus bicolor Tickell (Day), p. 791. Type locality same as preceding form. Placed by Day under *Pseudochromis fuscus* but perhaps a good species or subspecies.

Geneiates Tickell (Day), p. 804. Type by monotypy and/or present designation *G. ferruginosus* Tickell (Day). Probably a synonym of *Brotula* but perhaps a good genus. Hubbs (Copeia, 1944: 163) has mentioned this name in his discussion of *Brotula*.

Geneiates ferruginosus Tickell (Day), p. 804. Type locality Saddle Island, off Kyouk Phoo, Arrakan. Doubtfully identified by Day with *Brotula multibarbata* from Japan. See also Hubbs (loc. cit.).

Duxordia Tickell (Day), p. 805. Type by monotypy *Duxordia fluviatilis* Tickell (Day). Probably a synonym of *Leiocassis* but perhaps available for a subgenus. Day described the type species as a new species, *Leiocassis fluviatilis*, on p. 805. The type locality is the Anin, a stream arising near Weywoon, Wagroo, Tenasserim.

The fact that "manuscript names" mentioned without acceptance but in connection with a description are validly published and available for use should restrain authors from mentioning them.—George S. Myers.

PHYSICULUS JORDANI, A NEW GADOID FISH FROM DEEP WATER OFF JAPAN[1]

By James Böhlke and Giles W. Mead

Among those fishes labeled *Physiculus japonicus* Hilgendorf in the Stanford University collections we have found a single specimen apparently different from the others. After comparing this fish with the species and synonyms listed by Norman (1937, p. 54) and with other related forms referred to in the Zoölogical Record, it is evident that this specimen represents an undescribed species. In many characters, notably by the absence of the chin barbel, the new species seems to be most closely related to *Physiculus edelmanni* Brauer 1906, from deep water off the coast of East Africa, and *P. filifer* (Garman) 1899, from off the Pacific Coast of Panama.

Physiculus jordani, new species

Holotype: SU 21759; collected by the U.S. Fish Commission Steamer "Albatross", May 4, 1900, off Tsurugi Saki Light (S. 80° W. 4.3 m.), Honshu Island, Japan, Station 3695; depth 259-110 fms.; collected with an eight foot Tanner beam trawl. This specimen was acquired by exchange from the United States National Museum many years ago as *Physiculus japonicus*.

Description: Measurements of holotype[2]: Standard length 162, total length 182, greatest width of body 19 (12), greatest depth of body 27 (17), depth at ventral fin insertion 29 (18), least depth of caudal peduncle 3.5 (2), least width of caudal peduncle 1, length of caudal peduncle 15 (9), greatest width of head 26 (16), postorbital length of head 21 (13), fleshy interorbital 15.5 (10), snout 13 (8), eye 7.5 (5), maxillary 19 (12); tip of snout to first dorsal origin 40 (25), to second dorsal origin 49.5 (31), to anal origin 56.5 (35), to pectoral base 44.5 (27), to ventral origin 43.5 (27); length of base of first dorsal 7.5 (5), of second dorsal 102 (63), of anal fin 108 (67); pectoral fin length 24 (15), ventral fin length 24.5 (15), length of median caudal rays 10 (6), longest gill raker 4 (2).

First dorsal 8; second dorsal about 71; anal about 75; pectorals 22, 22; ventrals 6, 6; caudal 8-17-8 (possibly 7-19-7); gill rakers 5 + 10; branchiostegals 7.

General body form similar to *P. edelmanni* as figured by Brauer (1906, pl. 12, fig. 6). Greatest body depth 6 in standard length, 1.5 in head length. Body tapering evenly from anus to the very shallow peduncle; depth of caudal peduncle is contained 11.4 times in head; length of caudal peduncle (to base of median caudal rays) 2.7 in head. Head moderate, 4.1 in standard length. Snout short and broadly rounded, 3.1 in head. Eye small, 1.7 in snout, 2.1 in interorbital, 5.3 in head. Interorbital broad, flat or slightly convex, its width 2.6 in head. Maxillary 2.1 in head, reaching nearly to a vertical with posterior margin of pupil. Minute villiform teeth in bands on maxillaries and mandibles, absent from vomer and palatines. Branchiostegal membranes broadly united; joined to isthmus anteriorly; width of free fold about 2/3 diameter of eye. Gillrakers moderate, length of longest raker 10 in head.

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[1] Family Moridae, following the latest revision of the cods by Svetovidov, A. N., 1948, Gadiformes, *in:* Fauna SSSR, vol. 9, no. 4 (Zool. Inst. Akad. SSSR, new series, no. 34), 221 pp., pls. 1-72.

[2] These consist of measurements in millimeters followed, in parentheses, by the proportion in hundredths of the standard length.

Origin of the first dorsal fin above upper end of pectoral base, its distance from tip of snout 4.1 in standard length. Second dorsal distinct from first, distance from its origin to tip of snout 3.3 in standard length. Distance from snout to insertion of anal 2.9 in standard length. Ventrals inserted anterior to pectorals; their longest rays 1.6 in head length. Length of pectoral fin contained 1.7 in head. Midcaudal rays longest, their lengths about 4 in head. Chin barbel absent.

Peritoneum silvery inside, but in places so filled with black specks as to appear black.

Key to the Species of *Physiculus* Lacking the Barbel

1a. Ventrals 5, equal to or shorter than head; eye 4.8 in head; eye 1.15 in snout; anal with 66 rays.....*edelmanni* Brauer
2a. Ventrals 7, much longer than head; eye 4 in head; eye 1.3 in snout; anal with 70-71 rays.....*filifer* (Garman)
3a. Ventrals 6, shorter than head; eye 5.3 in head; eye 1.7 in snout; anal with 75 rays.....*jordani*, new species

Relationships: *Physiculus jordani* may be separated from *P. edelmanni* Brauer (1906, p. 274, pl. 12, fig. 6) by the characters utilized in the key above. From *P. filifer* (Garman, 1899, p. 182, pl. 41, figs. 2 and 2a), in addition to the characters enumerated in the key, it differs in lacking the elongate rays of the first dorsal fin, and in the possession of much shorter pectorals (pectorals 1.7 in head for *P. jordani*, less than 1.0 in head for *P. filifer*).

Of the species of *Physiculus* with the chin barbel, *P. jordani* appears to be closest to *P. argyropastus* Alcock (1893, p. 180, pl. 9, fig. 2), *P. grinnelli* Jordan and Jordan (1922, p. 22, pl. 1, fig. 3), and *P. nigrescens* Smith and Radcliffe (in Radcliffe, 1912, p. 105, pl. 22 fig. 1). The last three may be separated from each other on the basis of the fin ray counts, as follows:

	Second dorsal count	Anal count
P. grinnelli	73	65
P. nigrescens	66	72
P. argyropastus	55	57

Thus, *Physiculus jordani* is immediately differentiated from *P. grinnelli* and *P. argyropastus* by the number of fin rays, approaching only *P. nigrescens* in this respect. In addition to the differences in fin ray counts, *P. jordani* can be distinguished from *P. nigrescens* by its smaller eye, wider interorbital space, and gill raker count.

Named for David Starr Jordan.

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A NEW CUSK-EEL OF THE GENUS OPHIDION FROM CALIFORNIA WITH NOTES ON THE GENUS

By Robert R. Harry

While the writer was preparing a review of the Pacific cusk-eels of the genus *Otophidium*, two remarkable, though immature, specimens of the genus *Ophidion* from Santa Catalina Island off California were referred to him by the Bureau of Marine Fisheries, California Division of Fish and Game. These specimens have 7-8 gillrakers on the first arch, while all other known species of the genus *Ophidion* apparently have only 4. This new species is referable to the genus *Ophidion* because it (1) lacks opercular and ethmoid spines, (2) lacks pyloric caeca, (3) lacks scales on the head, (4) has a simple flat supramaxillary on the outer face of the maxillary, (5) has non-imbricate scales on the body arranged in oblique series. Apparently only two other species of *Ophidion (nigricaudum* and *iris)* are recorded from the Pacific Ocean, and these are known from single localities off Mexico.

Tentative Key to the Pacific Species of the Genus Ophidion

1a. Four erectile gillrakers on the lower limb of first arch; head length 4.9-5.1 into standard length.
2a. Teeth in roof of mouth larger than those in jaws; a prominent dark caudal spot (San Refugio Bay, Mexico).....*Ophidion nigricaudum* Breder (1936, p. 44)
2b. Teeth in roof of mouth not larger than those in jaws; no dark caudal spot (Gonzago Bay, Mexico).....*Ophidion iris* Breder (1936, p. 44)
1b. Seven or eight erectile gillrakers on lower limb of first arch; head length 7.6-7.9 into standard length (Santa Catalina Island, California).....*Ophidion novaculum,* new species

Ophidion novaculum, new species
Figures 1 and 2

Holotype: Stanford University 15964; 82.5 mm. in standard length; collected by Fred Woodworth on tne research vessel "Yellowfin", at the surface under a light; depth of water 18 fathoms; time 8 P. M. on January 15, 1950, at Avalon Bay, Santa Catalina Island, southern California.

Paratype: SU 15965; 84 mm. in standard length; collection data as for holotype.

Description: In the following description the measurements and counts for the holotype are given first and are followed (in parentheses) by those for the paratype. Measurements were made to the nearest tenth of a millimeter and divided into standard or head length as indicated. Both types appear to be very similar and the characteristics described agree in both specimens.

Body elongate, strongly compressed, deepest near dorsal origin; greatest depth 11.0 (10.2) into standard length.

Head small, strongly compressed, not so deep as body, its length 7.9 (7.6) into standard length. Head width distinctly greater than body width. Snout short, with lateral and indented medial ridges above the nostrils; snout length 3.9 (4.0) into head length. Nostrils in a line between middle of eye and tip of snout; anterior nostril a transverse slit, without a

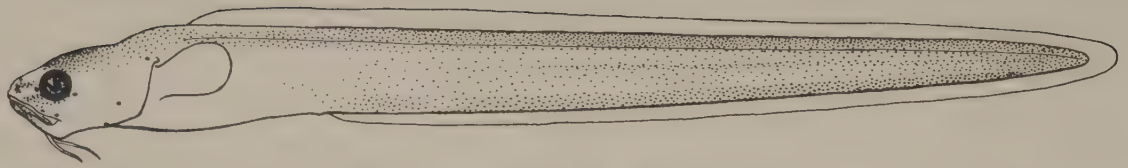

FIG. 1. Holotype of *Ophidion novaculum*.

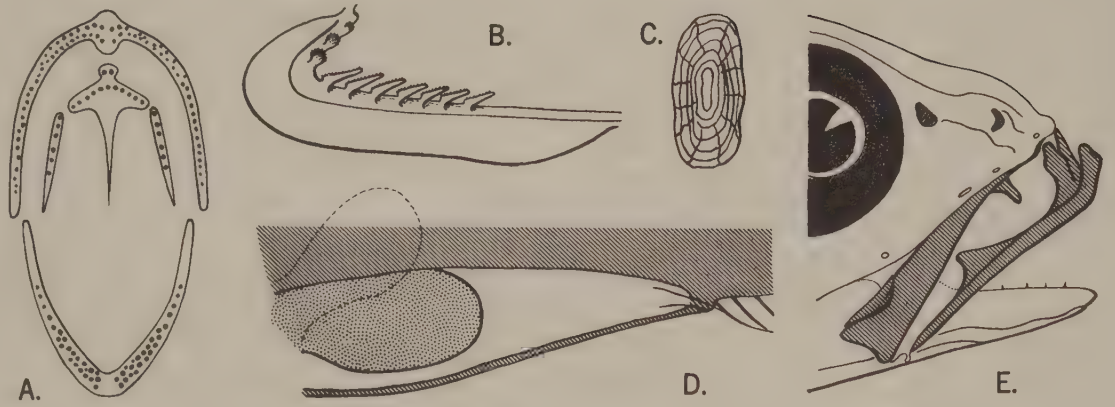

FIG. 2. Paratype of *Ophidion novaculum*. A. Dentition of upper and lower jaws. B. First right gill arch. C. Scale from behind tip of pectoral fin. D. Semidiagrammatic representation of left side of body cavity and air bladder. E. Side of head with upper jaw protracted.

raised rim; anterior nostril not under a labial fold; posterior nostril larger, oval, without a raised rim, very near border of eye. Edge of prefrontal not modified into a spine; therefore, no spine inside posterior nostril. Eye round, its posterior border far before middle of head length; eye diameter 3.8 (3.3) into head length. Interorbital slightly convex, with 2 longitudinal ridges and a median depression. Mouth strongly oblique. Upper jaw slightly indented at symphysis. Maxillary extending almost to a vertical from posterior border of lens. Hindborder of maxillary indented (Fig. 2e). Length of upper jaw (from tip of snout to posterior end of maxillary) 2.3 (2.4) into head length. Lips not papillose. Lower lip viewed laterally distinctly included. Teeth (examined by staining with alizarin red S) in upper jaw minute, fixed, subequal, in 2-3 irregular series (Fig. 2a). Teeth in lower jaw fixed, confined to anterior part of mandible, in 2 irregular series, slightly larger than teeth in upper jaw. Vomerine teeth tiny, blunt, arranged in a wedge-shaped patch of a single row in width; wedge preceded anteriorly by 1-2 teeth. A single row of 6 teeth on each palatine. Gill membranes joined to isthmus behind pelvic fin base below a vertical from posterior border of eye. Gillrakers on first arch 3+7 (3+8). All the rakers on the lower limb are moderately long and slender with finely denticulated inner margins (Fig. 2b). Length of longest raker on lower limb slightly less than lens diameter; each raker erectile, and reaching almost to tip of next anterior raker. Rakers above angle very short, spinulate tubercles. Opercle ending behind in a weak membranous flap; no spines developed. Branchiostegal rays 9 or 10.

Scales minute, cycloid, elongate (Fig. 2c); width of each scale approximately one-half the length. The focus is generally in the center and the radii are very weakly developed. Head, belly, and predorsal region scaleless. Scales on remainder of body widely spaced, imbedded, not imbricate, irregularly arranged, at oblique angles to one another. Lateral-line indistinct, interrupted, extending to base of caudal fin.

Swim bladder large, simple, ovate, its wall very thin and transparent, without a foramen (Fig. 2d). Swim bladder terminating more than the length of the pectoral fin before the anus. Anteriorly the air bladder is not thickened. No air sacs imbedded above the anal fin. The lack of a posterior foramen in both types might indicate that they are females, but sexual dimorphism in the form of the air bladder is probably not developed by this stage. In all genera and species of the Ophidiidae of which I have examined adults (including the genera *Ophidion, Otophidium, Lepophidium* and *Genypterus*) there is sexual dimorphism in the form of the air bladder. The males have a posterior foramen covered by a thin membrane, but this peculiarity is lacking in the females. An explanation for this phenomenon apparently has not been found.

Pyloric cæca absent. Peritoneum not silvery or black; completely lacking pigment.

Dorsal fin origin before a vertical from middle of pectoral fin. Distance from tip of snout to dorsal origin 6.2 (6.3) into standard length. Anal fin origin distinctly more than the length of the pectoral fin behind the tip of this fin. Distance from tip of snout to origin of anal fin 3.4 (3.4) into standard length. Pectoral fin rays 24 (24) on the left side, 25 (24) on the right. Each pelvic fin with one articulated ray divided at the base; its origin under front of eye; longest branch not reaching a vertical from pectoral fin base.

Measurements in percent of standard length: Body depth 9.1 (9.8); head length 12.7 (13.2); snout length 3.3 (3.3); eye diameter 3.4 (3.1); interorbital width 2.8 (3.3); upper jaw length 5.5 (5.5); distance from tip of snout to dorsal origin 16.1 (15.8); distance from tip of snout to anal origin 29.6 (29.7); pectoral fin length 7.0 (6.0); oblique distance between tip of pectoral fin and anal fin origin 9.6 (10.6).

Coloration: Color pattern very distinct and well preserved. Both type specimens with same coloration. Head heavily pigmented on occiput and gular region; scattered melanophores on jaws, preorbital, snout, suboculars, gular region and branchiostegal membranes. Iris solid black. Body dusky with large scattered melanophores indistinctly arranged on the sides into two longitudinal bands and a suffuse median lateral stripe (in this respect somewhat like *Otophidium marginatum*). No blotches or vertical bands. All fins completely without pigmentation.

Relationships: *Ophidion novaculum* seems to be more specialized than any other form of the genus. It transcends the known limits of the genus in the high number of gillrakers, but it should be pointed out that in both *Lepophidium* and *Otophidium* there is one group of species with 4 erectile rakers on the lower limb of the first arch and another group with 7 or more. This brings up the question of whether *Ophidion novaculum* might be the young of one of the species of *Otophidium* with a high number of gillrakers. This subgroup of *Otophidium* is known only from the temperate eastern Pacific and *Ophidion novaculum* occurs within this range. The fact remains that the only consistent difference found between the closely related genera *Ophidion* and *Otophidium* is the presence of a strong opercular spine in the latter genus and its complete absence in the former. Thus the opercular spine might not be developed in the small types of *Ophidion novaculum* and this species would actually be the young of an *Otophidium*. Nevertheless, I have examined young specimens of all the known eastern Pacific species of *Otophidium* down to those less than one-half the length of the types of *Ophidion novaculum* and they all have very well-developed opercular spines. In fact, in many instances the spines are proportionately larger in the young than in the adults. The largest specimen of *Otophidium* examined that lacked the opercular spine was a postlarva, 37 mm. in standard length. The smallest specimen of *Otophidium* found that possessed an opercular spine was a juvenile, also 37 mm. in standard length. The opercular bones of the paratype of *Ophidion novaculum* were stained with alizarin red S and the flesh dissected away on one side. There is no trace of a spine on the preoperculum (as has been reported for *Dannevigia* Whitley, a genus related to *Lepophidium*) nor on the operculum. The posterior border of the operculum is rounded as in the Atlantic species of *Ophidion* examined (including the generic type, *Ophidion barbatum* Linnaeus).

The types of *Ophidion novaculum* were compared with specimens of *Otophidium taylori* down to 72 mm. in length and found to be quite similar in practically all body proportions, and somewhat similar in coloration. Some of the prominent differences between *Otophidium taylori* and *Ophidion novaculum,* based on individuals of the same size (72-88 mm. in standard length), are: (1) a prominent opercular spine present in *taylori* but completely lacking in *novaculum*; (2) teeth on vomer irregularly arranged in at least 2 rows and in a triangular or wedge-shaped patch versus regularly arranged in a single wedge-shaped row preceded by 1-2 teeth; (3) approximately 15 teeth on the palatine arranged anteriorly in 3 rows versus approximately 5-6 teeth arranged in a single row; (4) teeth in upper jaw anteriorly in 3-4 rows versus 2 rows; (5) teeth in lower jaw in 4-5 rows versus 2-3 rows; (6) in general the teeth on the jaws, vomer, and palatines are twice as large in *taylori* as those in *novaculum;* (7) pharyngobranchial teeth in large patches of approximately 10 or more teeth in width versus small patches of only a few teeth in width; (8) pseudobranchiae consisting of 6-7 tufts versus 4; (9) eye larger in *taylori* (1.3-1.5 times) than in *novaculum;* (10) posterior nostril of *taylori* one-half the size of this structure in *novaculum;* (11) anterior nostril round with a raised tube versus crescent-shaped without a tube. In specimens of nearly the same size or larger than the types of *novaculum* (1) roof of mouth heavily pigmented versus completely lacking pigmentation; (2) peritoneum on belly and lower sides dusky or

dark versus complete lack of pigmentation; (3) dorsal and anal fins edged in brown or black versus complete lack of pigmentation in *novaculum*.

From the literature *Ophidion novaculum* superficially appears to be closest to the rare *Ophidion graellsi* (Poey, 1861) from the Atlantic. *Ophidion novaculum* agrees with *O. graellsi* in having 7-8 gillrakers on the lower limb of the first arch. Fortunately the specimen of *graellsi* described by Jordan and Evermann (1898, p. 2488) from Havana, Cuba (SU 1920; originally received from Poey), has been available for study. This specimen is not an *Ophidion* but shows closer relationships to the genera *Lepophidium* and *Genypterus*. It disagrees in several significant characters with the type of *O. graellsi*, but these differences might be attributed to the great difference in size between the specimens. In any event, the original description of *O. graellsi* by Poey (1861, p. 425) clearly indicates that he is also describing a species close to or in *Lepophidium*, and that this form should be removed from the genus *Ophidion*. The status of *O. graellsi* and several other unusual forms in this family will be discussed in a subsequent paper.

As has been previously intimated, *Ophidion novaculum* probably represents an offshoot well separated from all other members of this genus. This opinion is based primarily on the high number of gillrakers in the new species. In most other characters *O. novaculum* shows close agreement to other members of the genus. A few of the most striking differences between *O. novaculum* and the other Pacific species of the genus are listed, but (3) to (5) might be due to stage of development: (1) gillrakers 7-8 on the lower limb of the first arch in *novaculum*, as compared to 4 in *nigricaudum* and *iris*; (2) maxillary extending to a vertical under lens instead of at least to midway between posterior margin of pupil and eye; (3) predorsal region and belly scaleless versus scaled; (4) pelvic fins shorter, not reaching a vertical from pectoral fins, rather than extending well beyond the pectoral base; (5) vertical fins unpigmented instead of irregularly edged with dark.

The types of *Ophidion novaculum* are young but in all other species of ophidiids I have examined, the adult characters (except coloration) are well developed by this stage, and there should be no trouble in identifying adults with these specimens. The coloration will perhaps be different in larger examples, but this character is so variable, even among individuals of the same species in *Ophidion*, that it would be only of secondary use in identifications.

It is very possible that future collections will uncover additional species of *Ophidion* with a high number of gillrakers related to *O. novaculum*. In such event it might be advisable to erect two subgenera on the basis of gillrakers, but this step does not seem worth while at the present time. These species are most likely to be found in the central eastern Pacific, which on the basis of our present knowledge, is the center of distribution of the family.

Acknowledgments: I wish to thank Miss Anita Daugherty, Mr. Fred Woodworth, Mr. John Radovich, and Mr. John Fitch, all of the California Division of Fish and Game, for making these specimens available, and Dr. Carl L. Hubbs of the Scripps Institution of Oceanography and Dr. W. I. Follett of the California Academy of Sciences for reading the manuscript.

This new species is named *novaculum* (Latin = a dagger) because of the similarity of its body outline to a two-edged knife.

Notes on the Genus Ophidion: The Pacific species *Ophidion iris* and *O. nigricaudum* are poorly differentiated (see key in Breder, 1936, p. 47). Within most of the well known species of ophidiids studied by me there is individual variation from specimens having an iris uniformly black to those with the iris black above and silvery below. In addition, the caudal spot of *nigricaudum* could easily be an individual variation. The last key character given by Breder (see first key character of 2a and 2b, p. 1 of this paper) is of use, since there is sometimes specific variation in size of

teeth. Unfortunately most of the important characteristics for distinguishing cusk-eels are not mentioned for these two specimens.

The following species appear to belong in the genus *Ophidion: O. barbatum* Linnaeus (generic type) and *O. broussonetti* (Müller) from the Mediterranean, *O. beani* Jordan and Gilbert from the Gulf of Mexico, *O. nigricaudum* Breder and *O. iris* Breder from the Pacific coast of Mexico, and *O. novaculum*, new species, from California. The other species previously placed in *Ophidion* apparently should be referred to other genera. A surprisingly large number of the species described in the Ophidiidae have been placed in the wrong genus; and the genera of the family, particularly *Lepophidium*, are in need of revision.

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NEWS NOTES ON THE STANFORD CENTER OF FISH AND FISHERY WORK.—Nothing has previously appeared in this Bulletin regarding the staff and students working in ichthyology at Stanford, and it is felt that readers may be interested in our organization and personnel.

The Stanford Department of Biology has three administrative divisions: General Biology, located in Jordan Hall on the main University Quadrangle; the Natural History Museum, located in the Stanford Museum Building, about ¼ mile north of the Quad; and the Hopkins Marine Station, located on Monterey Bay, at Pacific Grove, California, about 100 miles south of the University. All three divisions are teaching units, presenting lecture and laboratory courses, and all take regular part in undergraduate teaching and graduate instruction leading to the degrees of A.M. and Ph.D. Most Stanford ichthyological work is done at the Museum and at the Marine Station.

At the Marine Station, ichthyological work is in the hands of Dr. Rolf Ling Bolin, Professor of Marine Biology and Oceanography, and Assistant Director of the Station. Professor Bolin currently gives the department's course in elementary ichthyology every summer at the Station and supervises the work of his group of graduate students there. Most of the latter are working on problems in marine ichthyology and fishery biology. Professor Bolin's own research has concerned especially the systematics of the Cottidae and Myctophidae, and he is now at work on a world monograph of the latter group. The Station maintains a small oceanographic vessel, the "Tage."

At the Natural History Museum, ichthyological work is guided by Dr. George Sprague Myers, Professor of Vertebrate Biology and Curator of Zoölogical Collections, and Dr. Donald Eugene Wohlschlag, Assistant Professor of Biology. Professor Myers gives courses in general vertebrate phylogeny, zoögeography, and herpetology, in addition to one in advanced systematic

ichthyology, and supervises graduate students in systematic ichthyology and herpetology. In addition he is chief curator of zoölogical collections in the Museum. Professor Wohlschlag currently gives courses in biometry, limnology, conservation, and fishery biology, and supervises graduate students intending to enter fresh-water fishery biology. Miss Margaret Hamilton Storey, Assistant Curator of Zoölogical Collections, and who gives our course in Museum Methods, is in direct charge of curatorial work in zoölogy, of the Museum's zoölogical library, and of editorial work on the Bulletin. There are two Museum sections other than Zoölogy: Entomology (Professor Gordon Floyd Ferris, in charge); and the Dudley Herbarium (Professor Ira Loren Wiggins, Director of the Museum, in charge). The Museum is devoted wholly to teaching and research. It maintains no exhibits.

The Museum's fish collection, begun by David Starr Jordan in 1891, is now one of the half-dozen most important in the world. While the number of specimens is not accurately known, there are probably something over 500,000 fishes. The collection has recently been enriched by the addition of large sections of the Bermuda and Pacific deep-sea and shore collections obtained by Dr. William Beebe, generously turned over to us by him. The fish collection was under the direct charge of Dr. Albert W. C. T. Herre, from 1928 until his retirement in 1946. In addition to the University's fish collection, the almost equally large collection of the California Academy of Sciences in San Francisco (40 miles north of Stanford) is available for research work, the two institutions having long maintained close relationships.

Under the leadership of David Starr Jordan, President and later Chancellor of the University, and of Professor Charles Henry Gilbert, Chairman of the Department of Zoölogy (later incorporated into the Department of Biology) many well known workers in systematic ichthyology were students at Stanford, among them Alvin Seale, John Otterbein Snyder, Edwin Chapin Starks, Albert W. C. T. Herre, Henry Weed Fowler, and Carl Leavitt Hubbs. Later, under the leadership of Professors Snyder and Starks, of Dr. Herre, and of Professor Tage Skogsberg at the Marine Station, R. L. Bolin and G. S. Myers were students. Among the more recent systematic ichthyologists who have studied at Stanford: Dr. Earl S. Herald (work on Syngnathidae; now in charge of the Steinhart Aquarium, San Francisco); Professor William A. Gosline (work on siluroids; now at the University of Hawaii); Miss Janet Haig (review of Eurasian Siluridae; now at the Hancock Foundation, Los Angeles); Dr. Martin R. Brittan (revision of *Rasbora*; now at San Diego State College); Professor Clark Hubbs (Clinidae; now at the University of Texas); Professor Harry W. Freeman (Agonidae; now at the University of South Carolina); and Dr. Fred H. Tarp (Embiotocidae; now at Contra Costa Junior College).

Graduate students now working on problems in systematic ichthyology at the Museum include: James Böhlke (Characidae); John C. Briggs (Gobiesocidae); Herman Adair Fehlmann (eel-like blennies); Robert R. Harry (Iniomi); Giles W. Mead (Clupeidae; young fishes); Norman J. Wilimovsky (berycoids; Arctic fishes).

Fishery biology and convervation have held an important place at Stanford ever since the work of David Starr Jordan on the International Fur Seal Commission in the 1890's. In 1910-12 Professor Gilbert ushered in the modern era of American fishery biology with his long-continued study of the life history of the sockeye salmon in British Columbia. Work of this type was continued by Professor Snyder and by Professor Willis Horton Rich, who guided fishery work at Stanford from 1927 until his retirement in 1950.

A large number of Stanford men, aside from Professors Gilbert, Snyder and Rich, have contributed notably to fishery work. Among them we may mention: Dr. W. F. Thompson, sometime Director of the School of Fisheries of the University of Washington, and of several fishery investigations; Mr. O.

E. Sette, Chief of the Pacific Oceanic Fishery Investigations, Honolulu; Mr. William C. Herrington, Special Assistant to the Undersecretary of State, for fisheries, in Washington; Dr. L. A. Walford, Chief of the Branch of Fishery Biology, U. S. Fish and Wildlife Service, Washington; Dr. D. V. Villadolid, Director of Fisheries of the Philippine Republic; Mr. V. E. Brock, Director of Fisheries for Hawaii; Mr. J. C. Marr, Chief of South Pacific Investigations, Fish and Wildlife Service, Stanford; and Messrs. A. C. Taft, in charge of inland fisheries, and R. C. Croker, in charge of marine fisheries, California Department of Fish and Game, San Francisco.

Among other Stanford men and women who have contributed much to fish or fishery work are: In the U. S. Fish and Wildlife Service: J. T. Barnaby, O. B. Cope, H. H. Eckles, Frances Felin, M. G. Hanavan, H. B. Holmes, S. G. Jewett, Jr., G. B. Kelez, M. J. Lindner, G. I. Murphy, G. A. Rounsefell, K. Stanton, Seton H. Thompson, Elizabeth Vaughan. In the California Department of Fish and Game: †P. Bonnot, Frances N. Clark, R. D. Collyer, Jr., *Brian Curtis, Anita E. Daugherty, W. A. Dill, D. H. Fry, Jr., H. C. Godsil, F. B. Hagermann, H. McCully, P. M. Roedel, *N. B. Scofield, W. L. Scofield, L. Shapovalov, H. G. Orcutt, J. H. Wales. In Washington State service: J. A. Craig. In teaching or research: P. Doudoroff, Laura Clark Hubbs (Mrs. Carl L. Hubbs), D. C. G. MacKay, H. C. McMillin, Masamitsu Oshima, Dixie L. Ray, E. Ray, V. M. Tanner. In Brazil: A. L. Gomes, Alba A. Maranhão. In Peru: A. Landa. In Venezuela: A. Fernandez-Yepez. In Costa Rica: J. Cardona-Cooper. In Mexico: R. S. S. Nuñez. In the F A O, Italy: H. Rosa. In the Philippines: P. R. Manacop, R. R. Medina, H. R. Montalban, I. A. Ronquillo, A. M. Sarenas, F. F. Talavera. In Egypt: I. A. Aboul-Ela. In India: V. G. Jhingran, H. Lall Arora, R. R. Prasad. († = recently deceased; * = retired.)

Three governmental fisheries agencies maintain headquarters and laboratories at Stanford, the South Pacific (U. S. coast) Investigations of the Fish and Wildlife Service, under Mr. Marr; the Western Fresh-water Investigations of the same Service, under Dr. O. B. Cope; and certain research projects of the California Division of Fish and Game. Cooperation of the University faculty and staff with these agencies is close, and Mr. Marr and Mr. Taft are honorary Lecturers in the Department. In addition an informal group consisting of all the fish and fishery workers and students in the Stanford area (called the "Fischverein") meets nearly every month (except in summer) to hear speakers and discuss matters of mutual interest. Meetings usually have an attendance of from 30 to 40 persons, an indication of the importance of the Stanford area in ichthyological work.

Unfortunately, funds to support publication of the Bulletin are very small and much more material is available than we can print. No really extensive papers can be published except with help from outside sources. Most of the fishery research of both faculty and students is the result of work done in connection with governmental agencies, and the results are usually published by those agencies. For this reason, relatively few papers on fishery biology have appeared in the Bulletin.

DESCRIPTION OF A NEW AUCHENIPTERID CATFISH OF THE GENUS PSEUDEPAPTERUS FROM THE AMAZON BASIN

By James Böhlke

Upon comparing a specimen of the auchenipterid genus *Pseudepapterus* from the Rio Negro with a specimen identified as *Pseudepapterus hasemani* (Steindachner, 1915, p. 68) from the Peruvian Amazon, it was immediately evident that the two forms were not the same species. As the generic status of *Pseudepapterus* as distinct from *Auchenipterus* is still subject to considerable doubt and a decision must await the accumulation of more material, the Rio Negro specimen has also been compared with specimens or descriptions of all the species included by Gosline (1945, p. 14) in *Auchenipterus*.

The new species has a higher anal ray count and a lower ventral ray count than any described species of *Auchenipterus*, and a lower pectoral and ventral ray count than *Pseudepapterus hasemani*.

Pseudepapterus cucuhyensis, new species
Figure 1

Holotype: SU 16788, from a sandbank at Cucuhy on the Columbian border, Rio Negro, Brazil; collected by the late Dr. Carl Ternetz, February 14, 1925.

Description: Measurements in thousandths of standard length, counts, and the important proportions are presented in Table 1. These are accompanied by a comparison with Steindachner's description of *Pseudepapterus hasemani* and a specimen also identified as that species from the upper Amazon in Peru.[1]

Body elongate, very compressed, its greatest depth occurring along the anterior portion of the anal fin and contained 4.6 in standard length. Least depth of caudal peduncle 2.0 in head, 10.1 in standard length. Head short, its dorsal aspect concave, its length 5.0 in standard length. Head width 1.9 in head length. Gape short, failing to reach anterior margin of eye; lower jaw included. Eye large, placed rather low on head, its horizontal diameter greatest, 0.9 in snout, 3.0 in head. Interorbital convex, slightly wider than snout length, equal to eye, 2.9 in head. Gill rakers long and slender, 7+11 on the first gill arch.

All barbels reaching at least slightly past anal fin origin, the maxillaries shortest, the inner mandibulars longest. Pectoral pore present, moderate in size. Pectoral spine serrated along its inner edge, the serrations directed proximally. Longest pectoral rays reaching beyond anterior end of ventral base when the fin is appressed. Longest ventral rays reaching beyond anal fin origin; inner ventral rays not connected across midventral surface of body. Dorsal fin very short and low, the spine unserrated. Adipose fin present, inserted far posteriorly. Procurrent caudal rays numerous, connected by a membrane, resembling the condition found in the pygidiid genus *Ochmacanthus*, although not as extensive.

Lateral line present, dendritic in form, with short vertical branches given off at inconstant intervals.

[1] SU 34211; Ambyiacu River, near Pebas, Peru; collected by W. G. Scherer, July 31, 1937.
This specimen is at variance with Steindachner's description of *Pseudepapterus hasemani* in several respects, i.e., in the placement of pectoral and ventral fins, but is here, at least provisionally, identified with that name.

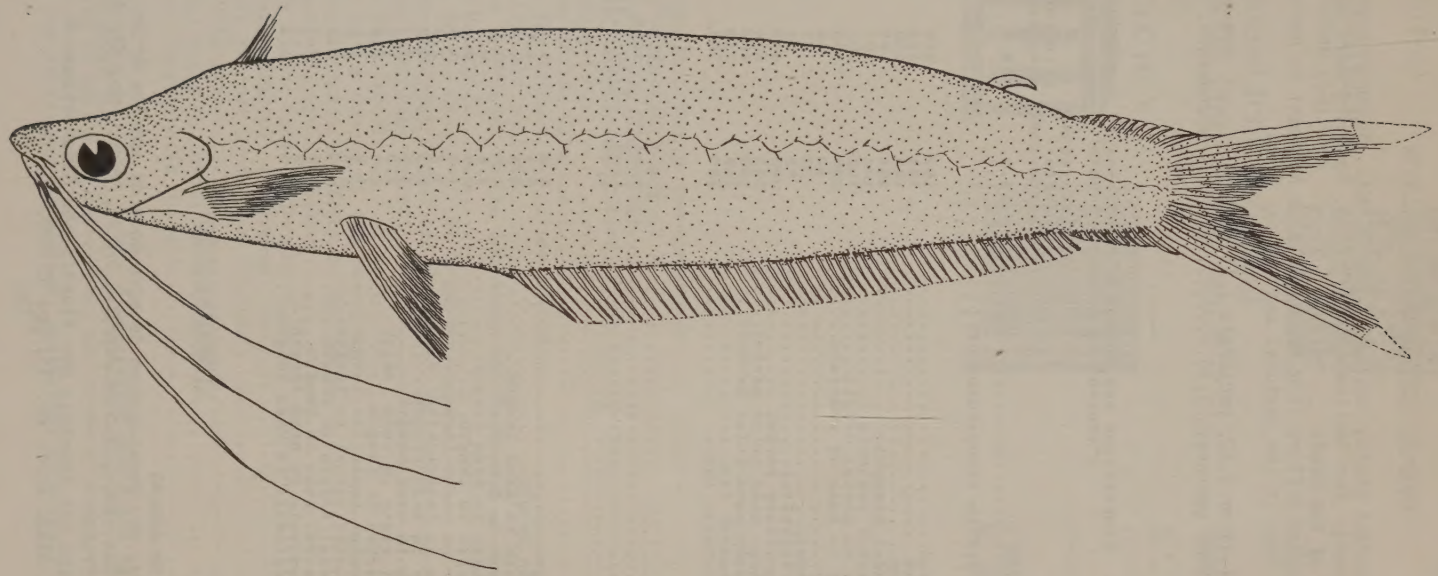

FIG. 1. Holotype of *Pseudepapterus cucunyensis*, SU 16788, 52.5 mm. standard length.
(Drawn by Miss Catherine S. Werner.)

Color in alcohol nearly uniformly light tan. Melanophores sprinkled more or less evenly over entire sides of fish, becoming more dense on the dorsal surface of the head.

This new species differs from *Pseudepapterus hasemani* in having a larger eye, and fewer rays in the pectoral and ventral fins.

1a. Ventrals I,11 or I,12; pectorals I,13 or I,14.....*P. hasemani* Steind.
2a. Ventrals I,8; pectorals I,10.....*P. cucuhyensis*, new species

Table 1. Proportions and Counts of Specimens of *Pseudepapterus* ("length" is standard length)

	P. hasemani (after Steindachner)	Peruvian specimen	*P. cucuhyensis*
Length.....	93.0	59.5	52.5
The following are in thousandths of length:			
Length of head.....	182	218	200
Width of head.....	104	113	105
Depth of body.....	195	218	219
Depth of caudal peduncle.....	104	92	99
Length of caudal peduncle.....	104	101	107
Tip of snout to dorsal origin.....	169	202	210
Tip of snout to base of ventrals.....	260	303	324
Eye diameter.....	52	42	67
Length of snout.....	52	67	63
Width of interorbital.....	78	84	69
Length of maxillary barbel.....	390	445	410
Length of inner mandibular barbel....	532	538	505
Length of outer mandibular barbel....	390	462	419
Length of ventral fin.....	149	143	152
Length of pectoral fin.....	182	168	162
Counts:			
Dorsal.....	I,5-6	I,5	I,5
Anal.....	3/54	3/56	3/54
Pectoral.....	I,14	I,13-I,13	I,10-I,10
Ventral.....	I,11	I,12-I,12	I,8-I,8
Proportions:			
Head in length.....	5.5	4.6	5.0
Body depth in length.....	5.1	4.6	4.6
Peduncle depth in head length.....	1.8	2.4	2.0
Peduncle depth in length.....	9.6	10.8	10.1
Peduncle length in head length.....	1.8	2.2	1.9
Peduncle length in length.....	9.6	9.9	9.4
Eye diameter in snout length.....	1.0	1.6	0.9
Eye diameter in interorbital width...	1.5	2.0	1.0
Eye diameter in head length.....	3.5	5.2	3.0
Snout length in head length.....	3.5	3.3	3.2
Interorbital width in head length....	2.3	2.6	2.9
Maxillary barbel in length.....	2.6	2.2	2.4
Inner mandibular barbel in length....	1.9	1.9	2.0
Outer mandibular barbel in length....	2.6	2.2	2.4
Snout to dorsal origin in length.....	5.9	5.0	4.8
Snout to ventral base in length.....	3.9	3.3	3.1
Length of ventrals in head length....	1.2	1.5	1.3
Length of pectorals in head length...	1.0	1.3	1.2

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